23rd International Conference From the Planck scale to the Electroweak scale (Planck 2021)

Monday, 28 June 2021 - Wednesday, 30 June 2021

Programme

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Monday, 28 June 2021

Opening Remarks (11:45 - 12:00)

-Conveners: Abel, Steven (IPPP)

Dark Universe / Astro-particles (12:00 - 13:40)

[1] Dark Matter Hunting in 2021 – How do you look for something when you don’t know what it is? (12:00)

Presenter: FAIRBAIRN, Malcolm (King's College London)

The Search for clues as to the nature of Dark Matter continues in more varied and novel ways than ever before and has never been more challenging nor more stimulating. In this talk I will describe a variety of approaches that have been worked on over the past years, focusing shamelessly on those I have been involved in personally. We can learn about dark matter through observations of dwarf galaxies, by trying to explain anomalies at particle physics experiments (both collider and direct detection experiments), and also by looking at the impact of the dark sector on relics left over from the big bang in the form of nuclei and gravitational waves. I will also discuss some of the other physics which may emerge along the way and briefly comment on what we can expect from the future.

[2] The quest for the origin of matter (12:50)

Presenter: DREWES, Marco

Observations strongly indicate that the baryonic matter in the observable universe is the remnant of a matter-antimatter asymmetry in the primordial plasma, which cannot be explained by the Standard Model of particle physics. If the new particles that are responsible for this asymmetry have masses below the TeV scale they may be discovered within the next decade. Using the example of low scale leptogenesis, we demonstrate that observables from different experiments can be combined to test the hypothesis that these particles are indeed the origin of matter. A key ingredient are state-of-the art simulations of processes in the early universe to make predictions for the properties of the new particles based on the requirement to explain the observed baryon-to-photon ratio.

Beyond the Standard Model (13:40 - 14:30)

[6] Axion Strings in the Sky (13:40)

Presenter: AGRAWAL, Prateek

I will present some remarkable signals of axion strings coupled to photons. There are compelling theoretical motivations to expect axion strings that persist in the sky today. There is a model-independent polarization rotation of CMB photons in the string background, equal to α_{em} up to a rational number related to the fundamental unit of electromagnetic charge. This manifests itself as a rotation of E-modes in the CMB polarization to B-modes. The current CMB experimental sensitivity to this rotation is about 1%, with many orders of magnitude improvement expected for future experiments. As these strings pass through galactic magnetic fields, they build up localized charge and current density traveling along the string. This sets up a cosmological plasma collider where collisions can occur at very high energies and produce spectacular astrophysical signals.

Coffee break: Come share a coffee break with us on gather.town! (Link communicated by email) (14:30 - 15:30)

Dark Universe / Astro-particles (15:30 - 16:20)

[3] Detecting Dark Matter in Celestial Bodies (15:30)

Presenter: LEANE, Rebecca

Stars and planets can be ideal playgrounds to discover dark matter. In this talk, I will review a range of dark matter searches using celestial objects, including neutron stars, exoplanets, solar-system planets, and our Sun. I will discuss different search strategies, their opportunities and limitations, and the interplay of regimes where different celestial objects are optimal detectors.

Beyond the Standard Model (16:20 - 18:00)

[4] Bounce of Nothing (16:20)

Presenter: GARCIA GARCIA, Isabel

[5] Amplitudes for Monopoles (17:10)

Presenter: TELEM, Ofri

On-shell methods are particularly suited for exploring the scattering of electrically and magnetically charged objects, for which there is no local and Lorentz invariant Lagrangian description. In this paper we show how to construct a Lorentz-invariant S-matrix for the scattering of electrically and magnetically charged particles. A key ingredient is a revision of our fundamental understanding of multi-particle representations of the Poincaré group. Surprisingly, the asymptotic states for electric-magnetic scattering transform with an additional little group phase, associated with pairs of electrically and magnetically charged particles. The corresponding “pairwise helicity” is identified with the quantized “cross product” of charges, e1g2 − e2g1, for every charge-monopole pair, and represents the extra angular momentum stored in the asymptotic electromagnetic field. We define a new kind of pairwise spinor-helicity variable, which serves as an additional building block for electric-magnetic scattering amplitudes. We then construct the most general 3-point S-matrix elements, as well as the full partial wave decomposition for the 2 → 2 fermion-monopole S-matrix. In particular, we derive the famous helicity flip in the lowest partial wave as a simple consequence of a generalized spin-helicity selection rule, as well as the full angular dependence for the higher partial waves. Our construction provides a significant new achievement for the on-shell program, succeeding where the Lagrangian description has so far failed.

Tuesday, 29 June 2021

Flavour phenomenology (12:00 - 14:30)

[7] B-Mesogenesis: Baryogenesis and Dark Matter from B Mesons (12:00)

Presenter: ESCUDERO, Miguel

I will present a new mechanism for Baryogenesis and Dark Matter production: B-Mesogenesis. Within the B-Mesogenesis paradigm, both the dark matter relic abundance and the baryon asymmetry of the Universe arise from the CP violating oscillations of B mesons and their subsequent decays in the early Universe. This mechanism would have distinctive experimental signals that I will discuss in detail: i) the new decay mode of B mesons into a baryon and missing energy and ii) a positive semileptonic asymmetry in neutral B meson decays. I will discuss the reach of current collider experiments to these signatures, and I will show that a combination of measurements at Belle II, LHCb, ATLAS & CMS can fully test B-Mesogenesis.

[8] Flavour Anomalies: Hints for BSM physics in expected and unexpected places (12:50)

Presenter: VAN DYK, Danny (TU München)

Quark flavour physics has received a lot of attention over the last decade. The influx of attention is driven by the so-called flavour anomalies: a series of statistically significant tensions between Standard Model predictions and measurements, shy of the celeberated 5 sigma significance. I will review the status of the so-called "b anomalies", a subset of the flavour anomalies, and provide context for the theoretical information required for their interpretation.

[9] Neutrinos as a Window to New Physics (13:40)

Presenter: KOPP, Joachim

We discuss some of the manifold ways in which neutrino experiments can be leveraged to probe physics beyond the Standard Model. Topics covered will include searches for light dark sectors, constraints on Standard Model Effective Field Theory (SMEFT) using LHC neutrinos, and neutrino magnetic moments. In the latter case, we highlight interesting connections to the muon g-2 anomaly and to some of the quark flavor anomalies.

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Higgs phenomenology (15:30 - 18:00)

[10] The SMEFT program at the LHC (15:30)

Presenter: BRIVIO, Ilaria

The LHC experiments are entering a precision era, where the sensitivity to indirect effects of new physics, i.e. discrepancies between data and SM predictions, will increase substantially. Searches for these signals are most conveniently performed within the framework of the Standard Model Effective Field Theory (SMEFT), that allows to implement a very ambitious program: a systematic search for inconsistencies with SM predictions in a large number of different processes, from which "agnostic" information about new physics can be extracted via a combined SMEFT interpretation. I will review the current status of this effort, that has seen important theoretical and experimental advancements in recent years. I will focus in particular on studies in the Higgs sector and on the complementarities between Higgs, electroweak and top quark processes.

[12] Prospects for Higgs measurements at future colliders (16:20)

Presenter: MANGANO, Michelangelo (CERN)

I review the potential of future colliders to improve the knowledge of Higgs properties, emphasizing the synergy and complementarity between lepton and hadron facilities.

[11] Higgs Physics at Future(^2) Colliders (17:10)

Presenter: FRANCESCHINI, Roberto (Rome 3 University)

I will discuss where do we stand in the task of characterizing the Higgs boson at LHC, the future prospects to learn more from the HL-LHC and future colliders presently under study. I will focus in particular on the long term goals in the exploration of Higgs boson properties and and possible lessons to be learned about electroweak symmetry breaking.

Wednesday, 30 June 2021

String Phenomenology (12:00 - 14:30)

[14] Bootstrapping Cosmological Correlations (12:00)

Presenter: BAUMANN, Daniel

Cosmology is famously an observational rather than an experimental science. No experimentalists were present in the early universe, and the birth and subsequent evolution of the universe cannot be repeated. Instead, we can only measure the spatial correlations between cosmological structures at late times. A central challenge of modern cosmology is to construct a consistent "history" of the universe that explains these correlations. In the last few years, a new bootstrap approach was developed to understand this history using physical consistency conditions alone. In this talk, I will describe the basic idea behind this "cosmological bootstrap" and explain why it promises new insights into the physics of the very early universe.

[15] SU(3)-Holonomy and SU(3)-Structure metrics from Machine Learning (12:50)

Presenter: ANDERSON, Lara B.

The metric on the compact internal geometry of a string compacitification has long stood as an important missing piece in the study of low energy physics arising from string theory. I will review recent progress using machine learning to approximate Calabi-Yau and SU(3)-structure metrics, including for the first time their dependence. These methods are demonstrated for Calabi-Yau as well as SU(3)-structure manifolds.

[13] Light Fermions and the Swampland (13:40)

Presenter: VALENZUELA, Irene

Quantum gravity can have important implications for Particle Physics and Cosmology. In this talk, I will describe the state-of-the-art and phenomenological implications of the AdS Distance conjecture and the Non-susy AdS Instability conjecture. In particular, we consider constraints on D-dimensional theories in Minkowski, dS and AdS backgrounds in the light of these swampland conjectures as applied to their compacti cation in a circle. For Minkowski and dS vacua the results may be summarized by a light fermion conjecture which states that in theories with a positive first non-vanishing supertrace $(-1)^{k+1}Str(M^{2k}) > 0$, a surplus of light fermions with mass $m_f < \Lambda_D^{1/D}$ must be present, where Λ_D is the cosmological constant. The case of AdS can be made consistent with the mild but not the strong version of the AdS Distance conjecture. I will also apply the above constraints to the Standard Model of particle physics, obtaining that it would be inconsistent in Minkowski space but consistent in dS if the lightest neutrino is Dirac and lighter than the cosmological constant scale, unless there is light fermionic dark matter. This can be translated to an upper bound on the EW scale which may shed some light into the naturalness issues observed in our universe.

Coffee Break: Come share a coffee break with us on gather.town! (Link communicated by email) (14:30 - 15:00)

Quantum algorithms and technologies (15:00 - 16:40)

[16] New Technologies for Dark Matter Detection (15:00)

Presenter: HOCHBERG, Yonit

The exploration of dark matter beyond the WIMP is of vital importance towards resolving the identity of dark matter. I will discuss new proposals for the direct detection of light dark matter which hold much promise. These include the use of superconducting nanowires, two-dimensional targets such as graphene, and heavy fermion materials. Considering dark matter interactions with these targets, I will demonstrate the potential of the light dark matter direct detection program in upcoming years.

[17] Quantum Technologies for New-physics Searches (15:50)

Presenter: SAFRONOVA, Marianna

The extraordinary advances in quantum control of matter and light have been transformative for precision measurements enabling probes of the most basic laws of Nature to gain a fundamental understanding of the physical Universe. Exceptional versatility, inventiveness, and rapid development of precision experiments supported by continuous technological advances and improved atomic and molecular theory led to rapid development of many avenues to explore new physics. I will give an overview of atomic and molecular physics searches for physics beyond the standard model and then focus on dark matter searches with atomic and nuclear clocks.

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Muon Anomalies (17:10 - 19:30)

[19] The B anomalies (17:10)

Presenter: PATEL (LHCB), Mitesh (Imperial College London)

An overview of the anomalies observed in measurements of neutral- and charged-current b quark transitions will be presented. Experimental and theoretical challenges for the relevant measurements will be discussed, and at outlook for future developments that may give clarity presented.

[20] Belle II: status and prospects (17:45)

Presenter: Dr KUHR (BELLE II), Thomas

The Belle II experiment at the SuperKEKB energy-asymmetric e+e− collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The target luminosity of the machine is 6×10^{35} cm$^{−2}$s$^{−1}$ and the Belle II experiment aims to record 50 ab$^{−1}$ of data, a factor of 50 more than its predecessor. With this data set, Belle II will be able to measure the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the matrix elements and their phases, with unprecedented precision and explore the B anomalies. Belle II has also a unique capability to search for low mass dark matter and low mass mediators. In this presentation, we will review the status of the Belle II detector, the results of the planned measurements with the full available Belle II data set, and the prospects for physics at Belle II.

[21] Fermilab Muon g-2: from a_\mu to g (18:20)

Presenter: Dr SCHRECKENBERGER (FERMILAB G-2 COLLABORATION), Adam

The Fermilab Muon g-2 Collaboration recently measured the muon magnetic anomaly with an unprecedented precision of 0.46 ppm. The new result is consistent with the measurement published by the g-2 experiment based at Brookhaven National Laboratory, and a difference of 4.2 standard deviations exists between the Standard Model prediction recommended by the Muon g-2 Theory Initiative and the combined Fermilab and Brookhaven measurements. This talk will describe the Fermilab experiment and the latest measurement of the muon magnetic anomaly.

[22] Theory perspective on the flavour anomalies (18:55)

Presenter: Dr BLANKE, Monika

Over the past few years, several anomalies related to the violation of lepton flavour universality emerged in charged and neutral current B meson decays, and also the longstanding tension in the muon g-2 has been strengthened by recent data. In this talk I will review possible New Physics explanations of these anomalies and discuss how they can be probed by complementary observables in the flavour sector and beyond.

Concluding Remarks (19:30 - 19:50)

-Conveners: Spannowsky, Michael (IPPP, Durham University)