Partikeldagarna 2020 (virtual), organised by Uppsala

Monday, November 23, 2020 - Wednesday, November 25, 2020

Book of Abstracts

Contents

Monday afternoon / 2

Calculating Feynman diagrams with the Chirality-flow method

Authors: Andrew Lifson[1]; Malin Sjodahl[1]

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In recent papers we proposed the Chirality-flow method, a novel method that allows a one-line journey from a Standard-Model Feynman diagram to a complex number, which can then be easily squared. In this talk I will describe this method and show its power in some representative examples.

Abstract Track:

Theory

Wednesday morning / 3

Thermal WIMPs on the Brink

Author: Tim Linden[None]

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Weakly Interacting Dark Matter Particles (WIMPs) are among the most well-motivated models for particle dark matter. While these particles can be detected through direct, indirect, or collider experiments, only their indirect annihilation produces a guaranteed signal. Intriguingly, experimental searches using both gamma-rays and cosmic-rays are beginning to close in on this coveted "thermal annihilation cross-section". Intriguingly, several excesses in Galactic center gamma-rays and cosmic-ray antiprotons have been discovered. Even more intriguingly, these excesses may be consistent with each other. In this talk, I will summarize the current state of the field, and argue that there is hope of resolving this puzzle within the next five years.

Abstract Track:

Astroparticle physics

Monday afternoon / 4

Emittance Scans Studies at ATLAS ,CERN LHC

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Abstract
A new type of short beam separation scans ("Emittance Scans") was initiated at the ATLAS Experiment, at the CERN LHC, in 2018. Emittance scans are beam separation scans in which the beams are scanned across each other in the x and y planes. At every separation point we estimate the average interactions, also called the luminosity of the accelerator. These studies involved searching for a suitable fit function. The luminosity can then be computed from the resulting function. The purpose of these studies is to understand the beam quality and also cross check the performance of our algorithms during physics data taking.

Abstract Track:

Flash talk, LHC

Wednesday morning / 5

Lund group's activities in ALICE at LHC

Author: David Silvermyr[1]

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The ALICE experiment is currently undergoing a major detector upgrade during LS2 in order to make full use of the planned LHC luminosity increase for heavy-ion collisions from 2022. The Lund group has been active in the main ALICE tracking detector (TPC) from the start, and I wish to give an overview on the Lund group's activities both related to ALICE upgrades and physics analyses.

Abstract Track:

LHC

Monday afternoon / 6

Electroweak corrections to non-zero-pT Z-boson production at pp colliders

Authors: Rikkert Frederix[1]; Timea Vitos[1]

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We calculate fixed-order electroweak corrections to the angular coefficients parameterizing the Drell-Yan process in the Z-boson mass range. We examine how the electroweak corrections affect the Lam-Tung relation, which was measured at the LHC to deviate from the SM predictions. For the calculations, we introduce a technical single lepton cut in order to avoid a double-soft/collinear singularity in the electroweak corrections. We investigate how the size of this cut alters the NLO electroweak and NLO QCD corrections to the coefficients and the Lam-Tung relation.

Abstract Track:

Flash talk, theory

Wednesday morning / 7

Flamedisx: Fast likelihood analysis in more dimensions for xenon TPCs

Authors: Jelle Aalbers[1]; Vasile Cristian Antochi[1]; Jan Conrad[None]; Bart Pelssers[1]; Pueh-Leng Tan[1]

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Liquid xenon time-projection chambers are the world's most sensitive detectors for a wide range of dark matter candidates. We show that the statistical analysis of their data can be improved by replacing detector response Monte Carlo simulations with an equivalent deterministic calculation. This allows the use of high-dimensional undiscretized models, yielding up to ~2times better discrimination of the dominant backgrounds. In turn, this could significantly extend the physics reach of upcoming experiments such as XENONnT and LZ, and bring forward a potential 5sigma dark matter discovery by over a year.

Abstract Track:

Astroparticle physics

Monday afternoon / 8

How atoms respond to general dark matter-electron interactions

Author: Timon Emken[1]

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Conventional dark matter (DM) searches are looking for scattering events between DM particles of the galactic halo and nuclei in a detector target. For kinematic reasons, they lose sensitivity to masses below typically a few GeV. The most prominent strategy to probe sub-GeV masses is to search for DM-electron scatterings.

In modelling these interactions, the literature has been dominated by the "standard model of sub-GeV DM", in which the interactions are mediated by a "dark photon", the gauge boson of a new, broken U(1) symmetry. By avoiding this model dependence using effective theory methods, we can study more general, previously unexplored DM-electron interactions and how they excite and ionize atoms. In this general framework, new atomic response functions arise, which we compute for xenon and argon targets for the first time. Such new responses have interesting implications, not just for astroparticle, but also condensed matter physics.

Abstract Track:

Astroparticle physics

Tuesday afternoon / 9

Geometry Calibration of the IceCube Detector

Author: Matti Jansson[1]

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The IceCube detector has components drilled 2 km into the ice. While the depth has been calibrated so far there is no calibration for any horizontal shift from nominal. I will present the idea behind my calibration project and some results from proof of concepts.

Abstract Track:

Flash talk, Astroparticle physics

Wednesday morning / 10

Dark matter constraints from measurements of cosmic-ray positrons

Author: Isabelle John[1]

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Cosmic-ray positron measurements provide a powerful probe of dark matter annihilation. A possible contribution to the measured positron flux could come from dark matter annihilating or decaying into e+e- pairs. In this work, we combine a detailed scan of the cosmic-ray propagation parameter space using Galprop with a new time-, charge- and rigidity-dependent model for solar modulation to present improved constraints on the dark matter mass in the range from 20 to 600 GeV from recently published cosmic-ray positron data.

Abstract Track:

Flash talk, Astroparticle physics

Monday afternoon / 11

Search for neutrinos from precursors and afterglows of GRBs

Author: Kunal Deoskar[1]

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Gamma ray bursts (GRBs) have long been considered as a possible source of ultra high energy cosmic rays, which makes them a promising neutrino source candidate. Previous IceCube searches for neutrino correlations with GRBs focused on the prompt phase of the GRB and found no significant correlation between neutrino events and the observed GRBs. This motivates us to extend our search

beyond the prompt phase. A model-independent search using an unbinned maximum likelihood method is performed to look for muon neutrino correlations with the precursor and afterglow phases of gamma ray bursts and the results are presented. The analysis is applied to a selection of 733 GRBs searching for correlations of neutrino signals with GRB observations separately for the precursor and for the prompt+afterglow emission regions. We obtain the best-fit results for individual GRBs and the final significance for each search is evaluated using binomial tests. Neither of the two searches provides significant evidence of neutrino emission from GRBs during an extended time period up to two weeks before or after the prompt phase of gamma-ray emission. The top 20 results for each search along with the fitted parameters are presented.

Abstract Track:

Flash talk, Astroparticle physics

Monday afternoon / 12

Possible neutrino signature of hadron-quark phase transition in failing core-collapse supernovae

Author: Shuai Zha[1]

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We study the consequences of the hadron-quark phase transition in failing core-collapse supernovae, which lead to the stellar-mass black-hole formation. For progenitor models with a range of compactness, the supernova core collapses and bounces for a second time due to the appearance of quarks. However, this second bounce cannot overcome the ram pressure of the envelope and result in the revival of the supernova shock. The core oscillates with the excess kinetic energy, which leads to periodic neutrino emissions with a period of ms. Black-hole formation takes place in a third collapse after hundreds of ms. The periodic neutrino signal can be strong evidence of the hadron-quark phase transition in failing core-collapse supernovae.

Abstract Track:

Astroparticle physics

Monday afternoon / 13

Short distance contribution to the muon g-2

Authors: Johan Bijnens[None]; Nils Hermansson-Truedsson[None]; Laetitia Laub[None]; Antonio Rodriguez-Sanchez[None]

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We recently showed how to calculate the short-distance contributions to the hadronic light-by-light part of the muon anomalous magnetic moment by using an alternative operator product expansion , see arXiv:2008.13487 and arXiv:1908.03331. I will also show preliminary results of the gluonic perturbative corrections (work in progress). This work removes one of the barriers to higher theory precision in the muon anomalous magnetic moment as discussed in the white paper arXiv:2006.04822

Abstract Track:

Theory

Monday afternoon / 14

Time determination of hard scatter vertices using the ATLAS experiment's High Granularity Timing Detector - a machine learning approach

Authors: Mattias Gullstrand[None]; Stefan Maras[1]

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Starting in 2027, the HL-LHC will begin operation and deliver unprecedented luminosities allowing higher-precision measurements and searches for new physics processes. One central problem that arises in the ATLAS detector when reconstructing event information is to separate the interesting hard scatter (HS) vertex from uninteresting pileup (PU) vertices in a spatially compact environment. This problem becomes even harder to solve at higher luminosities. Our project relies on leveraging the time dimension by using information measured by the upcoming High-Granularity Timing Detector (HGTD). Using Monte Carlo simulated event data for HL-LHC that incorporates the HGTD, we propose to tackle this problem using a two-step machine learning model approach. First, we use an aggressive model to group tracks with the goal of having as many HS tracks in one group as possible. Secondly, we use a model that cleans up and rejects the PU tracks that do not belong in the group with the most HS tracks. Finally, we can use this group of predicted HS tracks to determine a time of the HS vertex. This approximated time can then be used to separate background processes from the signal process.

Abstract Track:

Flash talk, LHC

Tuesday afternoon / 15

HighNESS and Future Free Neutron Oscillation Searches @ ESS

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The European Spallation Source (ESS), presently under construction, in Lund, Sweden, is a multi-disciplinary international laboratory that will operate the world's most powerful pulsed neutron source. Supported by 3MEuro Research and Innovation Action within the EU Horizon 2020 program, a design study (HighNESS) is now underway for a lower liquid deuterium moderator and associated experiments made possible by the moderator . These experiments include a search for neutron conversions to antineutrons (nnbar) and measurements with ultra cold neutrons. A fundamental physics program is part of the mandate of the ESS and was identified as a missing capability of the highest importance in a recent ESS prioritization exercise. This talk focuses on the HighNESS program and other fundamental physics possibilities at the ESS with an emphasis on the nnbar program. The nnbar experiment is a two-step program, starting with the HIBEAM stage which would make high

precision searches for free neutrons converting to sterile neutrons and thus probing a possible dark sector whilst also performing R&D for the second stage of the experiment at which an improvement in sensitivity, compared with the last such search, to neutrons converting to antineutrons by three orders of magnitude can be obtained.

Abstract Track:

Instrumentation & facilities (including ESS and MAX IV)

Wednesday morning / 16

Light sterile neutrino thermalisation in 3+1 and low reheating scenarios

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The existence of a light sterile species of neutrino is still under consideration, as it may offer an explanation to anomalies in short-baseline neutrino oscillation experiments. However, among the difficulties encountered in including such an extra neutrino species in the zoo of well-motivated new particles, the strongest restriction may come from cosmological observations. As the light sterile would act as an additional source of radiation during the early stages of the Universe, its parameter space is constrained by the observed value of Neff, which disfavours the mixing parameters preferred by short-baseline anomalies. A way of reducing the inevitable tension is moving towards scenarios beyond the standard cosmology that allows for a reduction of Neff. One such scenario consists in assuming a very low reheating temperature.
After presenting the implications for Neff from a standard-cosmology sterile neutrino thermalisation, I describe the effect that a low reheating scenario can have on neutrino thermalisation, both of active and sterile species.
All results were obtained within the framework of a 3+1 scenario of neutrino oscillations, using the code FortEPiaNO, that can follow neutrino thermalisation including the full 4x4 mixing matrix.

Abstract Track:

Astroparticle physics

Wednesday morning / 17

Cross-cutting initiatives in dark matter related to the European Strategy and the Snowmass process

Authors: Caterina Doglioni[1]; Erin O'Sullivan[2]

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In this contribution, I will outline three ongoing efforts revolving around dark matter complementarity, in the spirit of fostering cross-talk and engagement between different communities.

The first topic of this contribution is the initiative for Dark Matter in Europe and Beyond. It aims to create a permanent and common platform to exploit synergies and complementarities in dark matter searches across different communities, as a broad and common approach to dark matter research is necessary given the nature of this challenge. In this short contribution, we discuss the origin of this initiative and its possible future evolution, as well as its plans to build an online meta-repository for dark matter resources.

The second topic of this contribution is the ESCAPE Dark Matter Test Science Project, being developed in the context of the ESCAPE project (https://projectescape.eu). It has the aim to find commonalities between different communities and experiments in the foundational tools needed to produce those results, in particular in terms of data management, data analysis and computing. As part of this TSP, we will convert the existing experimental data and software procedures to sustainable analysis pipelines as a prototype for selected direct detection, indirect detection, and collider experiments involved in ESCAPE. The goal of this TSP is to aid the development of the European Open Science Cloud to store, distribute and provide data access to the dark matter scientific community, also making this data searchable, while respecting experiment Open Data Policies.

The third topic of this contribution is taking shape within the ongoing Snowmass process which will lead to the particle physics prioritisation inputs at the end of 2020. Since dark matter is a science driver that crosses multiple Snowmass Frontiers, a complementary approach that combines theory, experiment, observation, instrumentation, and computation is necessary to make progress in this domain. This effort aims to present specific case studies and milestones that emphasize that complementarity between these various fields of research must receive attention in the Snowmass process and by the DM community.

Note: I am also happy if this becomes a flash talk and I'll pick one of the topics, in case there isn't enough time for everyone's presentations and we have to privilege early career researcher presentation.

Abstract Track:

Cross-field collaborative initiatives

Tuesday afternoon / 18

Trigger-level analysis in ATLAS

Authors: Caterina Marcon[1]; Caterina Doglioni[1]; Oxana Smirnova[1]

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Traditional decision-making processes require that data is collected first, then analyzed. This model is not sustainable when the quantity of data is too large to be recorded for subsequent analysis. The Large Hadron Collider at CERN collides protons up to 30 million times per second: the majority of these events need to be rejected to comply with data processing and storage constraints. While this strategy works for many physics searches (e.g. Higgs, leptonic processes), it misses key classes of events where the signal is buried in irreducible backgrounds. This is why the Trigger Level Analysis technique has been introduced in the ATLAS experiment: the analysis is done in real-time within the decision-making system, allowing to record orders of magnitude more events that can be used e.g. for dark matter searches. All this data also needs to be analysed after being recorded, and a key component of the Trigger Level Analysis is the statistical analysis procedure in presence of an unprecedented number of data events to analyse. This flash talk will focus on the statistical analysis strategies employed by the analysis to identify minuscule signals on top of enormous backgrounds.

Abstract Track:

Flash talk, LHC

Tuesday afternoon / 19

A Neutron-Antineutron Annihilation Detector for the NNBAR Experiment

Author: Katherine Dunne[1]

Co-authors: David Anthony Milstead [1]; Anders Oskarsson [2]; Samuel Silverstein [1]; Bernhard Meirose [3]

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The existence of baryon number violating processes is considered a necessary condition to explain the observed matter-antimatter asymmetry in the universe. The construction of the European Spallation Source (ESS) provides a unique opportunity to exploit a high intensity beam of free, cold neutrons to perform searches for baryon number violation. The NNBAR/HIBEAM experiment will be the cutting-edge free neutron search for n⟶nbar and n⟶sterile n oscillations housed at the ESS, with a >1000 gain in sensitivity compared to the previous 1990s search at ILL.

The NNBAR detector will be capable of identifying neutron-antineutron annihilation events within a Carbon foil target. The signal is a multiplicity of pions with a final state invariant mass <2 GeV. The major detector subsystems will be vertex reconstruction with silicon, tracking with an Argon TPC, and a novel calorimeter design. Calorimetry for lower energy pions is a technical challenge due to poor energy resolution due to large fluctuations in energy deposition from the showers created in traditional sampling calorimeters. This talk will present the NNBAR detector concept, as well as ongoing work towards a prototype calorimeter at Stockholm University.

Abstract Track:

Instrumentation & facilities (including ESS and MAX IV)

Tuesday afternoon / 20

Measurement of the snow accumulation in Antarctica with a neutrino radio detector and extension to measure the index-of-refraction profile.

Author: Jakob Beise[1]

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High-energy neutrino astronomy has become a powerful tool to explore the most extreme environments in our universe. High energy neutrinos are detected most efficiently via the Askaryan effect in ice, where a particle cascade induced by the neutrino interaction produces coherent radio emission. There are several pilot radio arrays at the moment, among them ARIANNA at the Ross Ice Shelf and the South Pole. In order to reconstruct the neutrino energy with high precision, the snow accumulation must be monitored in real time. Therefore, one ARIANNA station was extended with a radio emitter that allows the measurement of the snow accumulation with unprecedented precision. I will present 14 months of measured data and furthermore show how the measurement setup

can be extended to also measure the change of the index-of-refraction with depth, another property relevant for reconstruction of the neutrino properties.

Abstract Track:

Flash talk, Astroparticle physics

Tuesday afternoon / 21

ZH spin-off analysis

Author: Christina Dimitriadi[1]

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Several HH searches are already being performed in ATLAS with different final states, but no evidence of SM-like HH production is expected until High-Luminosity LHC. The associated production of a single Higgs boson via ZH is a background in HH searches. When considering ZH, the cross-section is larger than for the corresponding SM-like HH channel. A slight modification of the HH searches to detect ZH instead of HH with a focus on the $bb\gamma\gamma$ and $bb\tau\tau$ channels, as a first step towards HH detection, is ongoing. Upper limits will be placed on ZH by using the full Run-2 dataset, while an evidence may be reached in Run-3.

Abstract Track:

Flash talk, LHC

Wednesday morning / 22

Dark matter at future colliders, astrophysics and non-collider experiments

Authors: Rebeca Gonzalez Suarez[1]; Caterina Doglioni[2]

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One overarching objective of science is to further our understanding of the Universe and its composition. The nature of dark matter (DM), corresponding to 85% of the matter currently present in the universe is still unknown. The presence and distribution of DM is detected through its gravitational interactions by observatories and experiments, while the interactions of DM with ordinary matter particles can be observed indirectly and directly in astrophysics experiments. These interactions also allow for DM to be produced in collisions of ordinary matter and observed in experiments at colliders and at particle accelerators, and provide complementary information about dark matter - ordinary matter interactions. Data from this wealth of astrophysics and particle physics experiments, combined with theoretical models and interpretations, will shed new light on dark matter.
This contribution will specifically focus on the synergies between present and future collider experiments (such as LHC and the Future Circular Collider that could be built at CERN), beyond-collider accelerator experiments, and astrophysics experiments.

Abstract Track:

Flash talk, cross-cutting collaboration

Tuesday afternoon / **23**

Cosmic ray backgrounds at the NNBAR experiment

Author: Sze Chun Yiu[1]

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The NNBAR experiment would look for neutrons transforming to antineutrons with a sensitivity improvement of three orders of magnitude compared with the previous search. At the last search, cosmic particles were the dominant background. Understanding the signature that cosmic particles leave in the NNBAR detector is therefore crucial. In this talk, predictions of cosmic ray backgrounds made with the CRY model and interfaced to a NNBAR detector simulation are shown. The strategy for dealing with this background is also described.

Abstract Track:

Flash talk, Instrumentation

Tuesday afternoon / **24**

Dark Mesons at the LHC

Author: Olga Sunneborn Gudnadottir[1]

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One of the unanswered questions remaining in particle physics is "What is Dark Matter?". There are many different ways of searching for it; directly, indirectly, and in colliders. However, since so little is still known about it, theoretical attempts to describe it are as different as they are many. In my talk, I will describe the analysis that I am performing within the ATLAS experiment at the LHC. We are using the full Run 2 dataset to search for pair production of Dark Mesons, composite objects of the constituents of a new, strongly coupled Dark Sector – similar to the Standard Model QCD sector. Previous analyses have focused on single production, and there is still a vast parameter space left that has not been excluded. If we do observe Dark Mesons, this would imply the existence of a strongly coupled Dark Sector with multiple particles, the number depending on the number of dark flavors, that would open up a completely new understanding of Dark Matter. If we do not observe them, we might be able to exclude a large part of the previous open parameter space.

Abstract Track:

Flash talk, LHC

Wednesday morning / **25**

Observing soft-spectrum gamma-ray sources with the future ALTO observatory

Authors: Mohanraj Senniappan[1]; Yvonne Becherini[1]; Michael Punch[None]; Satyendra Thoudam[2]; Jean-Pierre Ernenwein[3]; Tomas Bylund[1]; Gasper Kukec Mezek[1]

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Astrophysical jets in active galaxies and gamma-ray bursts (GRBs) accelerate charged particles, giving rise to fluxes of very-high-energy (VHE) gamma-rays. While observing high redshift GRBs on Earth, the photon spectrum gets softer at VHEs due to the extra-galactic background light (EBL) absorption. Additionally, detecting such VHE gamma-rays is a probe to search for axion-like particles and to test Lorentz invariance violation. ALTO is a R&D project for the design and prototyping of a very-high-energy (200 GeV - 100 TeV) gamma-ray observatory using particle detectors optimized to regularly monitor such distant soft-spectrum sources. In the R&D phase of ALTO, the expected detection performance on such targets is obtained using a dedicated simulation, reconstruction and analysis. I will present the status of the prototyping effort and the simulated performance of the large-scale ALTO array.

Abstract Track:

Astroparticle physics

Wednesday morning / 26

The next step of ALTO: The Cosmic Multiperspective Event Tracker (COMET)

Authors: Gasper Kukec Mezek[1]; Yvonne Becherini[1]; Michael Punch[None]; Satyendra Thoudam[2]; Jean-Pierre Ernenwein[3]; Tomas Bylund[1]; Mohanraj Senniappan[1]

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The ground-based ALTO array is being developed for observation of atmospheric air showers induced by very-high-energy (VHE) gamma-rays at energies above ~200 GeV, thus covering emission spectra of soft-spectrum sources. Its particle detector array, consisting of water Cherenkov detectors and scintillation detectors, overlooks a large portion of the sky and enables detection of VHE gamma-rays regardless of weather conditions.
During darkness, the addition of atmospheric Cherenkov light HiSCORE-type detectors will improve the reconstruction of arrival direction, energy and shower maximum for gamma-ray induced showers in the atmosphere, all crucial elements for the reduction of background contamination from cosmic rays. When coupling particle detection with atmospheric Cherenkov light detection, the instrument becomes a Cosmic Multiperspective Event Tracker (COMET). Using its full observational capacity ALTO/COMET will be able to search for new VHE gamma-ray sources and investigate exotic physical phenomena.
The status of ALTO/COMET R&D activities will be presented, including the construction and operation of its atmospheric Cherenkov light detector prototypes.

Abstract Track:

Flash talk, Astroparticle physics

Monday afternoon / **27**

An introduction to EuCAPT

Authors: David Marsh[1]; error message[None]

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The European Consortium for Astroparticle Theory (EuCAPT) was founded in 2019 with the aim of supporting and bringing together the European community of theoretical astroparticle physicists and cosmologists. This short talk will explain the organisational structure, scope and plans of EuCAPT.

Abstract Track:

Astroparticle physics

Tuesday afternoon / **28**

Exploring the high energy neutrino universe: IceCube, the IceCube Upgrade, and IceCube-Gen2

Author: Erin O'Sullivan[1]

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IceCube is an astrophysical neutrino detector that uses photosensors embedded in a cubic kilometer of glacial ice at the South Pole. Over the past decade, IceCube has discovered a diffuse, high-energy flux of extragalactic neutrinos, and has reported the first likely multimessenger association involving high energy neutrinos.

In light of these findings, we are now looking towards the future at what neutrino astronomy can become over the next decade. IceCube will deploy a denser infill of photosensors in 2022 and 2023, aimed at extending our low energy capabilities as well as improving the directional reconstruction of incoming neutrinos, an important factor in identifying multimessenger coincidences. We are also eyeing an even grander vision; IceCube-Gen2 would increase the instrumented volume of the detector, enhancing our sensitivity to high energy neutrinos by an order of magnitude and allowing us to truly begin an age of robust high energy neutrino astronomy from transient sources.

In this talk I will discuss how the Swedish groups are working towards realizing this vision of next-generation neutrino astronomy, including building a new in-ice camera, improving our multimessenger searches, and exploring new physics scenarios.

Abstract Track:

Astroparticle physics

Tuesday afternoon / 29

Collision muons analysis using the Tile Calorimeter of the ATLAS detector

Author: Stefio Yosse Andrean[1]

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The Tile Calorimeter (TileCal) of ATLAS is a hadronic calorimeter system placed in the central region of the detector. Muons deposit energy according to a well known distribution as ionization, which makes them ideal particles for energy calibration. The study is performed using muons produced in decays of W bosons in LHC Run-2 data at $\sqrt{s} = 13$ TeV recorded by the ATLAS detector. The energy loss over path length of muons traversing each TileCal cells is measured and compared with simulation. The response uniformity over the azimuthal angle ϕ is also measured to detect any ϕ-modules that are deviating from the average. This is important since the jet energy scale calibration assumes calorimeter's uniform response in ϕ. The study shows a good agreement of response between data and simulation, and also a good uniformity over ϕ. It is also shown that the method is sensitive enough to detect individual cells with special geometry.

Abstract Track:

Flash talk, LHC

Monday afternoon / 30

Upgrades of the ATLAS Tile Calorimeter Readout Electronics for the High-Luminosity LHC

Author: Katherine Dunne[1]

Co-authors: Samuel Silverstein [1]; Christophe Clement [1]; Eduardo Valdes Santurio [2]; Christian Bohm [1]; Suhyun Lee [1]

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The High-Luminosity LHC (HL-LHC) is expected to provide a data set of 4000 fb-1 allowing precision Higgs physics and search for deviations from the Standard Model. The HL-LHC poses new challenges in terms of radiation hardness and requires an unprecedented ability to select interesting collisions (trigger) at the collision frequency with a fully digital trigger.

The ATLAS Hadronic Tile Calorimeter (TileCal) records hadronic shower energy depositions that are used for triggering and physics data analysis. HL-LHC requires a complete replacement of the TileCal readout chain, with new radiation hard electronics compatible with the fully digital trigger architecture.

This flash talk will discuss upgrades to the on-detector TileCal read-out and control board (Daughterboard). The Daughterboard sends continuous high-speed readout of digitized PMT samples, slow control, and monitoring data to and from off-detector electronics. We present a design that minimizes single points of failure with double-redundancy, brings an enhanced timing scheme, improves radiation tolerance by mitigating Single Event Latch-up (SEL) induced errors, and features a more robust power-up and current monitoring scheme.

Abstract Track:

Flash talk, LHC

Wednesday morning / 31

neos: Physics analysis as a differentiable program

Authors: Nathan Daniel Simpson[1]; Lukas Alexander Heinrich[2]

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The advent of deep learning has yielded powerful tools to automatically compute gradients of computations. This is because 'training a neural network' equates to iteratively updating its parameters using gradient descent to find the minimum of a loss function. Deep learning is then a subset of a broader paradigm; a workflow with free parameters that is end-to-end optimisable, provided one can keep track of the gradients all the way through. This paradigm is known as differentiable programming.

This work introduces neos, which is an example implementation of a fully differentiable HEP workflow, made possible by leveraging the Python modules jax and pyhf. In particular, through using a technique called fixed-point differentiation, neos makes the frequentist construction of the profile likelihood differentiable. This allows a neural network-based summary statistic to be trained with respect to the expected p-value calculated downstream. Doing this results in an optimisation process that is aware of how every step in the workflow changes the p-value, including the modelling and treatment of nuisance parameters.

Abstract Track:

Flash talk, LHC

Monday afternoon / 32

Overview of Higgs Physics in ATLAS

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In the years following the initial discovery of a new scalar boson, data-analyses related to the Higgs sector in and beyond the Standard Model continue to be a central part of the ATLAS physics program. A number of new results have recently become available, following the exploitation of the full Run 2 proton-proton collision dataset recorded by the ATLAS experiment at the LHC. This talk provides an overview of the precision measurements of the Standard Model Higgs boson, as well as searches for Higgs boson pairs and for exotic scalar states predicted by models with an extended Higgs sector, with a focus on the activities of the Swedish ATLAS groups.

Abstract Track:

LHC

Tuesday afternoon / 33

Radio detection of ultra-high energy neutrinos

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Ultra-high energy (UHE) neutrinos (E > 1e16 eV) are connected to the most energetic phenomena in our universe and neutrino astronomy is a powerful tool to study the high-energy universe. Neutrinos can escape dense source environments and point back to their sources with sub-degree accuracy. In particular, multi-messenger analyses that combine neutrino detection with electromagnetic (e.g. gamma ray) and gravitational-wave observations bear huge potential to probe the sources of neutrinos and cosmic rays. The detection of neutrinos is challenging because of their small flux and cross-section, and requires the instrumentation of huge volumes. UHE neutrinos present a yet uncharted energy region. They can be efficiently measured with a sparse array of radio detectors, and the cold (ant-)arctic ice is an optimal target material.
I will report on the pilot radio neutrino detectors installed on the Ross ice shelf and at the South Pole, and the plans for the RNO-G detector in Greenland with deployment starting in 2021. I will discuss how neutrinos can be measured with a radio detector and how their properties can be reconstructed from the short radio flash. I will present plans for a large-scale radio neutrino detector as part of the IceCube-Gen2 project and discuss its prospects.

Abstract Track:

Astroparticle physics

Monday afternoon / 34

Performance and operations of the ATLAS detector (including preparation towards Run-3)

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While the LHC completed its second run in 2018, analyses of the 140 fb^{-1} data recorded by the ATLAS experiment during that period are in full swing. In order to provide the best possible sensitivity to Standard Model and new physics, the collaboration is reprocessing the full Run-2 dataset with improved calibrations as well as simulations in all relevant areas.

The four ATLAS-Sweden groups are deeply involved in this refinement of detector calibrations and performance. Critical efforts, among others described in this presentation, concern the calibration of the calorimeter's energy scale and the transition radiation tracker, as well as the identification

of heavy flavor jets. Additionally, the groups play leading roles in the development of tools for the experiment, for example to optimise data quality monitoring or to provide an online luminosity measurement. Finally, the groups contribute significantly to a successful start of Run-3 of the LHC, namely in areas such as the development of the new data quality monitoring framework, the improvement of pile-up suppression tools, and the commissioning of the triggers for Run-3.

Abstract Track:

LHC

Tuesday afternoon / **35**

ATLAS HL-LHC Upgrade

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The ATLAS experiment, located at the Large Hadron Collider (LHC) at CERN, uses a detector design optimized for the collection of data for a wide range of physics studies.
The experiment will benefit greatly from the upcoming High Luminosity LHC (HL-LHC) upgrade, which will provide higher luminosities, making new discoveries and higher-precision measurements possible.

Higher luminosity operation will result in a harsher detector environment.
To cope with the more demanding conditions and ensure capability to take full advantage of the higher lumonisities, the detector needs to be upgraded.

Swedish institutes are heavily involved in many important parts of the upgrade, namely in the upgrades of the detector's inner tracker (ITk) and tile calorimeter and the additions of a hardware track trigger system (HTT) and a new high-granularity timing detector (HGTD).
The talk will introduce these projects and give an overview of the contributions from Swedish institutes.

Abstract Track:

LHC

Tuesday afternoon / **36**

Revitalising longitudinal plasmon-axion conversion

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In the presence of an external magnetic field, the axion and the photon mix. In particular, the dispersion relation of a longitudinal plasmon always crosses the dispersion relation of the axion (for small axion masses), thus leading to a resonant conversion. While often neglected in the literature, these conversions can dominate axion production or absorption. Using thermal field theory and classical mechanics, we concisely derive the axion emission rate, applying it to astrophysical and laboratory scenarios. For the Sun, depending on the magnetic field profile, plasmon-axion conversion can dominate over Primakoff production at low energies ($\lesssim$200 eV). This both provides a new axion source for future helioscopes and, in the event of discovery, would probe the magnetic field structure of the Sun. Anticipating the detection of solar axions, we determine the potential for the planned next-generation helioscope, the International Axion Observatory (IAXO), to measure or constrain the solar magnetic field. For energy resolutions better than 10 eV, IAXO could access the inner 70% of the Sun and begin to constrain the field at the tachocline: the boundary between the radiative and convective zones. In the case of white dwarfs (WDs), plasmon-axion conversion provides a pure photon coupling probe of the axion, which may contribute significantly for low-mass WDs. Finally, we turn our attention to cryogenic plasmas to search for dark matter axions. Unlike current experiments, which repair the mismatch between axion and photon masses by breaking translational invariance (cavity and dielectric haloscopes), a plasma haloscope enables resonant conversion by matching the axion mass to a plasma frequency.

Abstract Track:

Astroparticle physics

Monday afternoon / 37

CLASH project – Probing strangeness production in small systems through new multi-differential measurements with ALICE at the LHC

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ALICE has observed that strangeness production increases with multiplicity in
small collision systems (proton-proton and proton-lead collisions) at LHC energies.
This means that proton-proton collisions cannot be seen as
incoherent sums of parton-parton collisions, an idea that has been central in
most proton-proton generators, for example PYTHIA. To accommodate the new ALICE results, different models introduce final state effects of very different phenomenological origin.
Multi-differential strange particle production studies can be used as key tool to discriminate among different final state effects at play

I will focus on new results from ALICE concerning π, K, ϕ, p, and Ξ production at mid-rapidity ($|\eta| < 0.8$) as a function of event shape and underlying event activity in proton-proton collisions at $\sqrt{s_{NN}}$ = 13 TeV. Transverse Spherocity (S_O) is an observable that allows to perform a topological selection of events that are "isotropic" (dominated by multiple soft processes) and "jetty" (where a single hard process is responsible for a significant part of the multiplicity). The underlying event activity is estimated by measuring the Transverse Charged Particle Multiplicity (R_{T}).
Furthermore, the two-particle correlation function is used to study the relative production of multi-strange baryons and non-strange/strange mesons. This measurement can shed light on whether the associated strangeness production can best be described by microcanonical or grand canonical hadronization models.

Finally, I will report on how these new multi-differential measurements compare to several state-of-the-art event generators.

Abstract Track:

LHC

Monday afternoon / 38

Status of the SHIFT project

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The presentation will summarize the scope and status of the SHIFT project, which is a collaboration between experimental and theoretical particle physicists at Chalmers, Stockholm and Uppsala. The focus is to search for top partners that can protect the mass of the Higgs boson from large quantum corrections. We study possible signatures of such top partners and search for them using data from the ATLAS experiment. This presentation will cover potential signatures, and direct searches for top partners in supersymmetry and composite Higgs models as well as indirect searches via precision measurements of processes involving top quarks. Furthermore, we study the production of a pair of Higgs bosons via 1-loop processes involving the propagation of the top quark as well as top partners in the loop.

Abstract Track:

LHC

Wednesday morning / 39

A careful look at phase transitions in the Standard Model Effective Field Theory (SMEFT)

Authors: José Eliel Camargo Molina[1]; Rikard Enberg[1]; Johan Löfgren[1]

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It is well known that quantum and temperature corrections to the scalar potential are important when considering vacuum dynamics and phase transition phenomena. It is also true that a naive application of perturbation theory gives gauge dependent results. Further complications arise when one is considering dim $d > 4$ operators in the Lagrangian.
In this work we present an extended prescription to consistently perform such calculations in a gauge invariant way, and apply it to the determination of the strength of the Electroweak Phase Transition in the SMEFT (Standard Model Effective Field Theory). In particular we discuss whether a first order phase transition is consistent with current limits on the SMEFT coefficients coming from all available data.

Abstract Track:

Astroparticle physics

Wednesday morning / 40

Novel crystal responses to general dark matter-electron interactions

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Direct detection experiments probing dark matter scattering off electrons in semiconductors provide leading constraints on sub-GeV dark matter. In this work, we model these interactions using non-relativistic effective operators, and identify and compute five dark matter and crystal response functions, four of them for the first time. We then use these responses to calculate the expected excitation rates in Silicon and Germanium crystals, and compute exclusion limits based on published experimental results.

Abstract Track:

Flash talk, Astroparticle physics

Monday afternoon / 41

Automated thermal cycling and testing of ATLAS Inner Tracker detector modules using a microcontroller

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The current ATLAS inner detector provided tracking and vertex reconstruction with high precision and efficiency during Run 1 and Run 2, and will continue to provide similar performance for Run 3 of the Large Hadron Collider (LHC). However, with the increased radiation damage and bandwidth requirements from the future High Luminosity LHC (HL-LHC), the ATLAS inner detector needs to be upgraded. The new Inner Tracker (ITk), is designed to maintain or even improve the performance of the ATLAS tracking, whilst operating in the harsher environment of the HL-LHC for a duration of ten years.

In this flash talk, I present my work at DESY, where we are developing a test setup controlled by a Raspberry Pi microcontroller to automate the thermal cycling procedure of the ITk detector modules. This procedure is a necessary part of the modules quality control and quality assurance, which is needed to ensure that each module has the required performance and reliability.

Abstract Track:

Flash talk, LHC

Monday afternoon / 43

Radiative corrections for the decay $\Sigma^0 \to \Lambda e^+ e^-$

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Electromagnetic form factors serve to explore the intrinsic structure of nucleons and their strangeness partners. With electron scattering at low energies the electromagnetic moments and radii of nucleons can be deduced. The corresponding experiments for hyperons are limited because of their unstable nature. Only for one process this turns to an advantage: the decay of the neutral Sigma hyperon to a Lambda hyperon and a real or virtual photon. Due to limited phase space the effects caused by the Sigma-to-Lambda transition form factors compete with the QED radiative corrections for the decay $\Sigma^0 \to \Lambda e^+ e^-$. In this talk we address the complete set of the inclusive NLO QED corrections to the Dalitz plot, calculated beyond the soft-photon approximation, i.e., over the whole range of the Dalitz plot and with no restrictions on the energy of the radiative photon.

Abstract Track:

Theory

Tuesday afternoon / 44

Study of X-ray selected blazars with IceCube data

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Blazars are among the most powerful emitters in the Universe over a broad range of wavelengths. The recent association of TXS 0506+056 with an astrophysical neutrino and observation of a neutrino excess from its direction by IceCube has further strengthened the case for the presence of a hadronic component in their emission, and paved way for efforts to detect this component by linking it to their high-energy EM emission. In this flash talk, I will briefly review my previous work on the multi-messenger study of blazars in gamma-rays and neutrinos, and present plans to extend this analysis by looking at X-ray selected blazars with IceCube data.

Abstract Track:

Flash talk, Astroparticle physics

Tuesday afternoon / 45

Searching for local group supernovae using high-energy neutrinos from CSM interaction

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IceCube monitors our galaxy for supernovae using neutrinos with energies of tens of MeV. However, the shock between the ejecta and the progenitor star's circumstellar material can create a high flux of neutrinos with energies on the order of TeV and above. These neutrinos would reach Earth 0.1 day - 1 year after the low-energy neutrinos. I will describe an analysis aimed to investigate whether we can extend IceCube's observational reach by using these high-energy neutrinos and design a search for hidden SN in our local group.

Abstract Track:

Flash talk, Astroparticle physics

Tuesday afternoon / 46

Phase transition configurations in de Sitter are O(4) symmetric

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In this collaboration between pure mathematics and cosmology we show that in de Sitter, bounce solutions, or the instanton configurations that trigger vacuum decay during inflation, are O(4) symmetric. This fact has so far been assumed through analogy with the flat spacetime case but never proved. The proof follows from recent progress in geometric PDE and min-max methods

Abstract Track:

Flash talk, cross-cutting collaboration

Tuesday afternoon / 47

Overview of BSM physics in ATLAS Sweden

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Beyond the Standard Model physics (BSM) is one of the major contributions from the ATLAS groups in Sweden. This talk highlights recent BSM analyses, such as searches for dark matter and long-lived particles, in R-parity conserving and R-parity violating scenarios. Other results from the 139 fb-1 LHC data collected by the ATLAS detector are also presented, such as the search for massive resonances into heavy quarks.

Abstract Track:

LHC

Wednesday morning / 48

LHCb research in Uppsala

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As a newly appointed professor in the nuclear physics division in Uppsala I would like present some recent results from my research in LHCb. I will give a brief introduction to LHCb and my main involvements the construction of the detector. Then I'll give a brief summary of two research topics that I have been involved in recently. The first topic is the discovery of the first doubly-charmed baryon and the measurements of its properties, and outline briefly the new area of research that this opens up. The second is the classic LHCb topic of time-dependent CP violation, where the first observation of time dependent CP asymmetries in Bs decays were presented at the Beauty conference in September 2020. In addition to being a milestone in the study of CP violation, the observation was made in decays dominated by higher-order diagrams and hence they provide sensitivity to BSM physics.

Abstract Track:

LHC

Monday afternoon / 49

Search for Light Dark Matter using a Primary Electron Beam

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The constituents of dark matter are still unknown, and the viable possibilities span a very large mass range. Specific scenarios for the origin of dark matter sharpen the focus on a narrower range of masses: the natural scenario where dark matter originates from thermal contact with familiar matter in the early Universe requires the DM mass to lie within about an MeV to 100 TeV. Considerable experimental attention has been given to exploring Weakly Interacting Massive Particles in the upper end of this range (few GeV – TeV), while the region MeV to ~GeV is largely unexplored. Most of the stable constituents of known matter have masses in this lower range, tantalizing hints for physics beyond the Standard Model have been found here, and a thermal origin for dark matter works in a simple and predictive manner in this mass range as well. It is therefore a priority to explore. If there is an interaction between light DM and ordinary matter, as there must be in the case of a thermal origin, then there necessarily is a production mechanism in accelerator-based experiments. The most sensitive way, (if the interaction is not electron-phobic) to search for this production is to use a primary electron beam to produce DM in fixed-target collisions. The Light Dark Matter eXperiment

(LDMX) is a planned electron-beam fixed-target missing-momentum experiment that has unique sensitivity to light DM in the sub-GeV range. The experiment requires a primary electron beam. In a first phase, this will be delivered by LCLS-II at SLAC into a dedicated beamline under construction. An even more powerful facility at CERN have been proposed. The Swedish engagement in LDMX is part of the Wallenberg project KAW-LDM. This contribution will give a brief overview of the theoretical motivation, the main experimental challenges and how they are addressed as well as projected sensitivities, and will focus on progress made over the past year.

Abstract Track:

Cross-field collaborative initiatives

Monday afternoon / 50

Welcome to Partikeldagarna

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Tuesday afternoon / 51

Deep Learning meets Physics

Machine learning has been successfully used in physics research for decades. With the advent of deep learning methods in computer science, a renaissance of machine learning in physics occurred in recent years. The seminar explains the basic ideas of deep learning, distinguishes deep learning from the classic data analysis and classic machine learning approaches and explains concepts and challenges of deep learning applications in particle and astroparticle physics.

Tuesday afternoon / 52

Flash talk questions

Monday afternoon / 53

Flash talk questions

Tuesday morning / 54

Panel discussion on accelerator-based infrastructures

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In this session session discusses funding strategies for large accelerator-based infrastructures, as it is the case for particle physics, with authors of the report and Swedish scientists. Anyone is welcome to add questions for the panel at [this link] and to contribute to the discussion during the session.

The recent report by VR can be found here: https://www.vr.se/analys/rapporter/vara-rapporter/2020-06-12-accelerator-based-infrastructures-in-the-fields-of-particle-and-nuclear-physics.html

Tuesday morning / 55

Report from VR+RFI (15'+5')

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Tuesday morning / 56

CERN Council including update of the European strategy for particle physics (20'+5')

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Tuesday morning / 57

Report from (R)ECFA (12+3)

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Abstract Track:

Tuesday morning / 58

Report from IPPOG (12+3)

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Tuesday morning / 59

Report from IUPAP (C4/C11) (12'+3')

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Tuesday morning / 60

Report from ACCU (CERN User Association) (12'+3')

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Wednesday morning / 61

Flash talk questions