NePSi 23

Report of Contributions

https://agenda.infn.it/e/nepsi23

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

Data-driven calculations of hadronic contributions to $(g-2)_\mu$

Wednesday, February 15, 2023 9:00 AM (30 minutes)

I will review the dispersive and data-driven calculations of the hadronic contributions to the Muon g-2, with emphasis on the hadronic vacuum polarization. I will discuss in detail the comparison with the lattice evaluation both of the total and of the intermediate window quantity, and the implications of the present discrepancy. I will conclude with an outlook on future developments.

Presenter: COLANGELO, Gilberto (Berna University)

Session Classification: Senior Session

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

Beam dynamics corrections to the anomalous spin precession frequency in the Muon g-2 experiment at Fermilab

Wednesday, February 15, 2023 9:30 AM (30 minutes)

The Muon □–2 experiment at Fermilab aims to measure the magnetic anomaly of muon to 140 parts-per-billion precision, which is about four times more precise than the predecessor experiment at Brookhaven National Laboratory. To that end, the experiment not only requires the accumulation of 21 times more of the detected positrons but a much better understanding and, thus, reduction of the systematic errors. An extensive analysis of correcting the systematic effects and assessing the corresponding systematic uncertainties was conducted and published for the Run-1 result in April 2021. This talk focuses on and summarizes the beam dynamics aspects of those systematic corrections to the anomalous spin precession frequency measurement. A few key differences in the Run-1 and the ongoing Run-2/3 analysis process will be briefly covered.

Presenter: KIM, On

Session Classification: Senior Session

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

Lattice calculation of the R-ratio smeared with Gaussian kernels

Wednesday, February 15, 2023 10:00 AM (20 minutes)

The ratio $R(s)$ of the cross-sections for $e^+e^- \to$ hadrons and $e^+e^- \to \mu^+\mu^-$ is a valuable energy-dependent probe of the hadronic sector of the Standard Model. Moreover, the experimental measurements of $R(s)$ are the inputs of the dispersive calculations of the leading hadronic vacuum polarization contribution to the muon $g-2$ and these are in significant tension with direct lattice calculations and with the muon $g-2$ experiment. In this talk we discuss the results of our first-principles lattice study of $R(s)$. By using a recently proposed method for extracting smeared spectral densities from Euclidean lattice correlators, we have calculated $R(s)$ convoluted with Gaussian kernels of different widths σ and central energies up to 2.5 GeV. Our theoretical results have been compared with the KNT19 compilation of experimental results smeared with the same Gaussian kernels and a tension (about three standard deviations) has been observed for $\sigma \sim 600$ MeV and central energies around the ρ resonance peak.

Presenter: DE SANTIS, Alessandro (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **46** Type: **Oral presentation**

Search for the direct production of slepton pairs in $\sqrt{s}$ = 13 TeV pp collision with the ATLAS detector

Wednesday, February 15, 2023 10:20 AM (20 minutes)

A search for the electroweak production of pairs of charged sleptons decaying into two-lepton final states with missing transverse momentum is presented. A simplified model of □-parity-conserving supersymmetry is considered: direct pair-production of sleptons (ℓℓ), with each decaying into a charged lepton and a □01 neutralino. The lightest neutralino (□01) is assumed to be the lightest supersymmetric particle (LSP). The analysis targets the experimentally challenging mass region where □(ℓ)–□(□01) is close to the □-boson mass (
moderately compressed" region). The decay topology is similar to those of SM processes, making it challenging to separate signal from background. The search uses 139~fb−1 of □√=13~TeV proton-proton collisions recorded by the ATLAS detector at the Large Hadron Collider. No significant excesses over the expected background are observed, therefore exclusion limits on the studied simplified model are reported in the mass plane at 95\% CL. Sleptons with masses up to 150 GeV are excluded at 95% CL for the case of a mass-splitting between sleptons and the LSP of 50 GeV. In particular, since electroweak-scale SUSY with light smuons and a light LSP can explain the □−2 anomaly for small tan□ values, exclusion limits are also set for selectrons and smuons separately and parts of the region excluded by this search in the □(□)–□(□01) plane are compatible with the (□−2)□ anomaly for small tan□ values.

Presenter: GRECO, Matteo (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

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

Single π^0 production in ⊠⊠ scattering at MUonE

Wednesday, February 15, 2023 3:50 PM (20 minutes)

The Standard Model theoretical prediction of the muon anomalous magnetic moment, $= (-2)/2$, presents a discrepancy of $4.2\ \sigma$ with respect to the combined Fermilab and BNL measurements.

The MUonE project is a recently proposed experiment at CERN that will help to shed light on this situation, by providing an independent determination of the leading order hadronic vacuum polarisation (HLO) contribution,
which dominates the theoretical uncertainty on , through the study of elastic muon-electron scattering at small momentum transfer.
In order to achieve an accuracy similar to the one of existing determinations of $^{\mathrm{HLO}}$, the projected experimental precision at MUonE is of the order of 10ppm. This precision level has to be reached also by the theoretical calculations, by considering all possible radiative corrections as well as all processes that can constitute a background to the experimental signal.

In this talk, the analysis of a potential source of reducible background at MUonE, coming from the ⊠0 production in muon-electron scattering, i.e. $\mu^{\pm}\to\mu^{\pm}\pi^0$, is presented.
This kind of study is motivated by the fact that the π^0 production is dynamically enhanced in the region of small electron and muon scattering angles, which is particularly interesting for MUonE.
Moreover, the effects of this same process as a background to possible New Physics searches at MUonE are analysed, in phase-space regions complementary to the elastic-scattering ones, where one can study processes such as the production of a light new gauge boson ⊠′ via the process $\mu^{\pm}\to\mu^{\pm}eZ'$ or of a dark photon through the process $\mu^{\pm}e\to\mu^{\pm}eA'$.

Presenter: DEL PIO, Clara Lavinia (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **48** Type: **Oral presentation**

The RBC/UKQCD g-2 program

Wednesday, February 15, 2023 11:10 AM (30 minutes)

I will give an overview of the RBC/UKQCD g-2 program including both the hadronic light-by-light as well as the hadronic vacuum polarization contribution.

Presenter: LEHNER, Christoph (Brookhaven National Laboratory)

Session Classification: Senior Session

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

Measurement of the anomalous spin precession frequency in the Muon g-2 experiment at Fermilab

Wednesday, February 15, 2023 4:40 PM (30 minutes)

The muon anomaly, $= \frac{(-2)}{2}$, is a low-energy observable which can be both measured and computed to high precision, making it a sensitive test of the Standard Model and a probe for new physics. The current discrepancy between the Standard Model calculation from the Muon -2 Theory Initiative [T. Aoyama et al. - Phys. Rept. 887 (2020), 1-166] and the experimental value is $\_ = (251 \pm 59)\ 10^{-11}$, with a significance of 4.2 .

The anomaly was measured with a precision of 0.54 ppm by the Brookhaven E821 experiment and the E989 experiment at Fermilab aims for a four-fold improvement in precision, to confirm or refute the discrepancy. In Spring 2021, E989 published the first results of with a precision of 0.46 ppm using the data from the 2018 data-taking campaign. The measurement of the anomalous muon spin precession frequency, , is based on the arrival time distribution of high-energy decay positrons observed by 24 electromagnetic calorimeters, placed around the inner circumference of a storage ring. This talk will present the analysis technique of and a preliminary status of the analysis performed on the datasets collected during Run 2 and 3 (2019 and 2020 campaigns).

Presenter: SORBARA, Matteo (Università degli Studi di Roma Tor Vergata & INFN Sezione Roma Tor Vergata)

Session Classification: Senior Session

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

Pseudoscalar meson contributions to the Hadronic Light-by-Light scattering in the muon –2

Wednesday, February 15, 2023 12:10 PM (20 minutes)

The error budget of the theory calculation of the muon –2 is dominated by two hadronic contributions: the Hadronic Vacuum Polarization (HVP) and the Hadronic Light-by-Light (HLbL) scattering. Reducing the error on these contributions is essential to match the future experimental precision.

In this talk, we present a lattice calculation of the three light pseudoscalar meson (π_0, η and η') transition form factors. We compare our results for the form factors with the experimental measurements. These form factors are an important input for the determination of the pseudoscalar-pole contributions to HLbL scattering in the muon –2 ($^{\text{p-pole}}_{\text{HLbL}}$). We compute $^{\text{p-pole}}_{\text{HLbL}}$ and compare it to the other current estimates.

Presenter: VERPLANKE, Willem (CPT Marseille)

Session Classification: Young Researchers Session

Contribution ID: **51** Type: **Oral presentation**

Kicker Transient Field Measurements for Muon g-2

Wednesday, February 15, 2023 6:10 PM (20 minutes)

The Muon $g-2$ experiment measures the muon magnetic moment anomaly a_μ by relating the precession frequencies of muons inside a magnetic storage ring to the strength of the magnetic field that they experience. A series of NMR instruments map the primary magnetic field, but some short-lived transient magnetic fields require alternative approaches to measure with sufficient precision. The kicker transient field is a magnetic perturbation created by eddy currents induced in metal inside the ring when the primary kicker field is pulsed. To measure the kicker transient field without altering its strength, three teams developed Faraday magnetometers that function without adding any metal into the system. These magnetometers send laser light through TGG crystals, where the polarization of light rotates proportionally to the strength of the surrounding magnetic field. This technique allowed the kicker transient field to be measured with milligauss-level sensitivity and megahertz-level bandwidth for the first time. Subsequent measurements have seen further improvements, with upgrades to the magnetometers reducing noise from mechanical vibrations. We present results from the UMass team's Fiber Optic Faraday Magnetometer, with an analysis of the kicker transient field and its newly reduced contribution to $g-2$'s overall uncertainty.

Presenter: KESSLER, David (University of Massachusetts Amherst)

Session Classification: Young Researchers Session

Contribution ID: **52** Type: **Oral presentation**

Correlating Charged Lepton g – 2 with Neutrino Magnetic Moments

Wednesday, February 15, 2023 6:30 PM (20 minutes)

We show that the models that induce neutrino magnetic moments while maintaining their small masses naturally also predict observable shifts in the muon anomalous magnetic moment. This shift is of the right magnitude to be consistent with the Brookhaven measurement as well as the recent Fermilab measurement of the muon g–2. This points out the direct correlation between the magnetic moment of SM charged lepton and neutral lepton (neutrino) by showing that the measurement of muon g–2 by the Fermilab experiment can be an in-direct and novel test of the neutrino magnetic-moment hypothesis, which can be as sensitive as other ongoing-neutrino/dark matter experiments. Such a correlation between muon g–2 and the neutrino magnetic moment is generic in models employing leptonic family symmetry to explain a naturally large neutrino magnetic moment. This talk will be based on results obtained with K.S. Babu, Manfred Lindner, and Vishnu P.K. and presented in hep-ph 2007.04291 and 2104.03291.

Presenter: JANA, Sudip (Max-Planck-Institut für Kernphysik)

Session Classification: Young Researchers Session

Contribution ID: **53** Type: **Oral presentation**

Window contributions to the Muon HVP from twisted mass lattice QCD

Wednesday, February 15, 2023 2:30 PM (30 minutes)

In this talk I will review the calculation of the short and intermediate window for g-2, based on our recent simulations performed int the Twisted Mass regularization of QCD, with physical pion mass and three different lattice spacings. Our results highlights that the tension with experimental measurement is concentrated in the intermediate energy region.

Presenter: SANFILIPPO, Francesco (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **54** Type: **not specified**

Simulations for the Muon g-2 Experiment at Fermilab

Wednesday, February 15, 2023 5:40 PM (30 minutes)

The main goal of the Fermilab Muon g-2 experiment is to determine the muon anomalous magnetic moment (a_μ) to a 140 parts per billion (ppb) uncertainty, to compare it with the Standard Model prediction. The value of a_\mu is determined by measuring two quantities: the anomalous spin precession frequency of positive muons circulating in a storage ring and the magnetic field experienced by the stored muons. In 2021, the collaboration published the first result with ~6% of the final statistics and a total uncertainty of 462 ppb dominated by the statistical contribution. This result is in agreement with the previously published measurement obtained at Brookhaven National Laboratory (BNL); the combination of the two results disagrees by 4.2 standard deviations with the most accurate theoretical prediction published in 2020 and by 1.5 standard deviations with the calculation that uses Lattice QCD results. To achieve the final uncertainty goal, the muon beam dynamics, from injection to storage until all muons decay, has to be fully under control. This talk, after describing the experimental technique, presents work on beam dynamics systematic studies using experimental data and simulation.

Presenter: DRIUTTI, Anna

Session Classification: Senior Session

Contribution ID: **55** Type: **not specified**

High precision calculations for the MUonE experiment

Wednesday, February 15, 2023 3:30 PM (20 minutes)

The muon anomalous magnetic moment $= (-2)/2$ has been measured at Brookhaven National Laboratory in 2001 and, more recently by the Fermilab Muon −2 Experiment. Their results deviate by $4.2\ \sigma$ from the Standard Model theoretical predictions. The largest source of theoretical error is the Hadronic Leading Order (HLO) contribution . This contribution can be calculated using dispersion relation techniques together with $^{+-}\rightarrow hadrons$ timelike data. Moreover, recently, has been also calculated using Lattice QCD techniques and their results seem to be in disagreement with the timelike determination. Thus, a third independent calculation for would be useful to understand the nature of the discrepancy of -2: in this respect, MUonE is a proposed experiment at CERN whose aim is to provide a new and independent determination of in the \textit{spacelike} region using muon-electron scattering at low momentum transfer. The MUonE experiment has a target accuracy of about 10 parts per million on the differential cross section, so that the error on is comparable with the timelike error. Hence, also the theoretical prediction of the differential cross section has to reach the same level of precision. A very precise calculation of the muon-electron scattering cross section with all the radiative corrections and backgrounds is required.
In this talk, the theoretical formulation for the NNLO photonic contributions and the NNLO real and virtual lepton pair contributions to scattering are described. Numerical results, obtained with a fully differential Monte Carlo event generator, are shown. Such contributions are essential to reach the precision needed for the MUonE experiment.

Presenter: BUDASSI, Ettore

Session Classification: Young Researchers Session

Contribution ID: **56** Type: **not specified**

Connected hadronic contribution to the muon g-2 from lattice QCD and QED

Wednesday, February 15, 2023 12:30 PM (20 minutes)

By replacing continuous space–time with a Euclidean lattice, lattice gauge theories provide a way to capture the non-perturbative effects in the muon g-2. We present first results by the RC collaborations towards obtaining a precise estimate of these effects using a novel local description of lattice QCD and QED, based on C boundary conditions in space.

Presenter: TAVELLA, Paola (ETH Zurich)

Session Classification: Young Researchers Session

Contribution ID: **58** Type: **not specified**

The MUonE experiment

Wednesday, February 15, 2023 3:00 PM (30 minutes)

The muon anomalous magnetic moment is currently one of the most intriguing measurements, as it marks a 4.2 ⊠ deviation from the reference prediction of the Standard Model, and is expected to provide an even more stringent test in the next few years with the experimental error reducing by a factor of four. In parallel the theoretical error need to be reduced. It is dominated by the non-perturbative hadronic contribution to the vacuum polarization (HVP), usually determined by a data-driven method, from the dispersive integral over the measured hadron production cross section in e^+e^- annihilations. The picture is now getting even more interesting, as an alternative precise determination of the HVP contribution from pure theory, by Lattice QCD, would bring the calculation close to the measurement, and seems to be incompatible with the data-driven prediction.
The MUonE experiment proposes a third, independent and competitive determination of the HVP contribution, from a precise measurement of the elastic muon-electron scattering at the CERN SPS. The project is challenging on both experimental aspects and the needed theory calculations. The main ideas and the status of the project will be presented.

Presenter: ABBIENDI, Giovanni (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **59** Type: **not specified**

The Muon g-2 Experiment: A Field Trip

Wednesday, February 15, 2023 11:40 AM (30 minutes)

The Muon g-2 Experiment at Fermi National Accelerator Laboratory was designed to measure the anomalous magnetic moment of the muon, , with a target precision of 140 parts-per-billion (ppb); a four-fold improvement over the former measurement at Brookhaven National Laboratory. The experiment was motivated by the ~3.5 standard deviation between the BNL result and the Standard Model prediction of ; which could be a hint of new physics. The first result at Fermilab from the Run-1 data taking period has achieved an uncertainty of 460 parts-per-billion and confirmed the BNL discrepancy, further increasing the tension with the Standard Model.
The experimental concept uses a polarized muon beam stored in an extremely homogeneous storage ring magnetic field. Parity violation in the weak decay is used as a spin analyzer; the detected rate of the decay electrons oscillates with the frequency, , in the magnetic field expressed in terms of the Larmor frequency of protons shielded in a spherical water sample, . Since is derived from the ratio of and , both are equally important and systematic uncertainties must be kept below 70 ppb for each observable. The magnetic field measurement system to determine consists of 378 new Nuclear Magnetic Resonance probes that constantly monitor the field, an upgraded in-vacuum field mapping system that scans the muon storage region over the full azimuth, and a special water-based probe to calibrate the probes of the field mapping system. The talk will give a short experimental overview and then focus on the details of the magnetic field measurement.

Presenter: WINTER, Peter (Argonne National Laboratory)

Session Classification: Senior Session

Contribution ID: **60** Type: **not specified**

The Strong2020 and RadioMonteCarlow activities

Wednesday, February 15, 2023 2:10 PM (20 minutes)

During the last 15 years the "Radio MontecarLow ("Radiative Corrections and Monte Carlo Generators for Low Energies") Working Group, see www.lnf.infn.it/wg/sighad/, has been providing valuable support to the development of radiative corrections and Monte Carlo generators for low energy e^+e^- data and tau-lepton decays. Its operation which started in 2006 proceeded until the last few years bringing together at 20 meetings both theorists and experimentalists, experts working in the field of e^+e^- physics and partly also the tau community and produced the report "Quest for precision in hadronic cross sections at low energy: Monte Carlo tools vs. experimental data" S. Actis et al. Eur. Phys. J. C 66, 585-686 (2010) (https://arxiv.org/abs/0912.0749), which has more than 300 citations.
While the working group has been operating for more than 15 years without a formal basis for funding, parts of our program have recently been included as a Joint Research Initiative in the group application of the European hadron physics community, STRONG2020, to the European Union, with a more specific goal of creating an annotated database for low-energy hadronic cross sections in e^+e^- collisions. The database will contain information about the reliability of the data sets, their systematic errors, and the treatment of RC.
We will report on both these initiatives.

Presenter: VENANZONI, Graziano (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **62** Type: **not specified**

A few considerations regarding the exclusive $b \to c\ell\bar{\nu}$ decays

Thursday, February 16, 2023 8:30 AM (30 minutes)

Presenter: BECIREVIC, Damir (LPT, Université Paris Sud and CNRS)

Session Classification: Senior Session

Contribution ID: **63** Type: **not specified**

Lepton flavour universality tests in $b \to s\ell\ell$ decays at LHCb experiment

Thursday, February 16, 2023 9:50 AM (20 minutes)

Several results in high energy physics experiments highlighted hints of new physics in semileptonic decays of B particles. Among the existing experiments, the LHCb detector plays a very important role in this sector. In fact, it is specifically designed for the study of particles containing b or c quarks. Some LHCb results suggested the violation of the lepton flavour universality stated in the Standard Model (SM) of particle physics. The confirmation of these results would lead to the discovery of new physics, such as heavy mediators.
A very good laboratory where to probe this SM concept are the rare b⟶ sll decays. Indeed, they are sensitive to possible contributions from heavy mediators, inaccessible to direct searches. LHCb already performed several kinds of analysis on b ⟶ sll decays. Among them, the branching ratio measurements and the angular analyses. The comparison between the decays to electrons and to muons might reveal differences between leptons families.
The most recent results of the b ⟶ sll analyses will be presented in this talk. Furthermore, future outlooks that could help to tackle the puzzle of the flavour anomalies will be discussed.

Presenter: BIOLCHINI, Alice (Nikhef National institute for subatomic physics (NL))

Session Classification: Young Researchers Session

Contribution ID: **65** Type: **not specified**

$B \to D^* \ell \nu$ from lattice QCD and its impact on V_{cb} and $R(D^*)$

Thursday, February 16, 2023 10:50 AM (30 minutes)

Presenter: VAQUERO, Alejandro (Universidad de Zaragoza)

Session Classification: Senior Session

Contribution ID: **66** Type: **not specified**

Much ado about nothing

Thursday, February 16, 2023 11:20 AM (30 minutes)

The Standard Model of particle physics leaves many fundamental questions unanswered, among which, for example, neutrino masses, matter-antimatter asymmetry and the nature of dark matter. Flavour physics (the intensity frontier) is one of the main fields of investigation to unveil the unsolved questions.
Several aspects of flavour physics, including the recent experimental "anomalies"in leptonic decays, are critically reviewed. New results and ideas to improve the accuracy of the theoretical predictions and future developments are discussed

Presenter: MARTINELLI, Guido (ROMA1)

Session Classification: Senior Session

Contribution ID: **67** Type: **not specified**

Highlights from the LHCb experiment

Thursday, February 16, 2023 9:00 AM (30 minutes)

The LHCb detector at the Large Hadron Collider is dedicated to the study of heavy-flavoured hadrons. Using large data samples accumulated during the first two runs of the LHC, the LHCb collaboration has performed various measurements providing a sensitive test of the Standard Model and strengthening our knowledge of flavour physics, QCD and electroweak processes. Selected recent results are presented and prospects are given for the new LHC run.

Presenter: TUCI, Giulia (PI)

Session Classification: Senior Session

Contribution ID: **68** Type: **not specified**

Searching for Z' and Leptoquarks at Future Colliders

Thursday, February 16, 2023 3:20 PM (20 minutes)

The Large Hadron Collider at CERN is currently our only tool for direct exploration of physics at the electroweak scale and above and the high-luminosity phase is planned to last until the late 2030s. Rare flavour-changing neutral current transitions $\rightarrow^{+-}$ probe higher energy scales than what is directly accessible at the LHC and therefore the presence of new physics in such transitions, as suggested by the present-day LHCb anomalies, would have a major impact on the motivation and planning of future colliders, with the 100 TeV future circular hadron collider (FCC-hh) and multi-TeV muon collider (MuC) being the most promising options for the energy frontier. In particular the latter has the advantages of both proton-proton and electron-positron colliders, combining high energy reach with high precision measurements.
The theoretical study of processes at a future MuC should take into account the fact that leptons, which are elementary particles in the Standard Model, can emit soft and collinear radiation, which for small transverse momentum can be factorized from the hard scattering and a description in terms of parton distribution functions (PDFs) can be introduced, similarly to what is done in case of proton colliders and the parton content of a proton.
In this talk, after a short presentation of the two future colliders mentioned above, I will quickly review our computation of the muon PDFs, which will be published at the beginning of the next year [1]. Then, following the work in [2], I will show some applications to New Physics searches at MuC and FCC-hh, focusing on ⊠′ and Leptoquarks. Since a final word on the flavour anomalies (due to either new physics or experimental systematics) might take a while, I will show the results we obtained with and without taking into account LHCb data.

References

[1] F. Garosi, D. Marzocca, S. Trifinopoulos; Standard Model parton distribution functions for lepton colliders (in progress)

[2] A. Azatov, F. Garosi, A. Greljo, D. Marzocca, J. Salko, S. Trifinopoulos; New physics in $\rightarrow$: FCC-hh or a muon collider?, JHEP 10 (2022) 149, [2205.13552]

Presenter: GAROSI, Francesco (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **69** Type: **not specified**

Development of the data acquisition system for the Mu2e STM detector

Thursday, February 16, 2023 4:00 PM (20 minutes)

The observation of a significant deviation in the muon g-2 relative to the Standard Model (SM) e+e- prediction is perhaps a harbinger of new muon interactions beyond the SM and in many models of physics beyond the SM (BSM) a significant rate of charged lepton flavour violating (CLFV) muon interactions is predicted. The Mu2e experiment at Fermilab will extend the sensitivity to BSM CLFV interactions by 4 orders of magnitude by seeking to observe the neutrinoless transition of a muon to an electron when captured by an aluminium target. Critical to this measurement is the determination of the number of muons captured by the aluminium target. This cannot be estimated very reliably from simulation since the rate of the parent pions is model dependent and there are uncertainties in the collection and transmission efficiencies of the solenoids. However, muons captured are accompanied by distinctive X-rays which can be used to determine the muon flux. X-rays of 347 keV, 844 keV and 1809 keV will be measured by the Stopping Target Monitor (STM), a High Purity Germanium detector (HPGe), to determine the muon rate. The X-rays create transient pulses in the detector, the height of which is related to the incident energy of the X-rays. To determine the rates of the three X-rays I have implemented a Moving Window Deconvolution (MWD) algorithm. The input parameters of this algorithm have been tested on real X-ray data from 137-Cs and 152-Eu radioactive sources and beam data from the HZDR gELBE bremsstrahlung facility and optimised using simulated data. Testing this algorithm on a simulation based on the physical processes taking place in the detector has allowed the MWD resolution and efficiency to be determined as a function of rate. Furthermore, the pulse shapes expected in the HPGe STM detector have a long decay tail and the amount of data generated is bigger than the available disk space available. I have developed a Zero-Suppression (ZS) algorithm to reduce the amount of raw data being stored and analysed. This algorithm has also been tested on real data and simulation. I will present performance results from the ZS and MWD algorithms and how these will be used to accurately determine the muon flux at Mu2e.

Presenter: ALVAREZ GARCIA, Claudia

Session Classification: Young Researchers Session

Contribution ID: **70** Type: **not specified**

Dilaton & Scale Invariance

Thursday, February 16, 2023 2:20 PM (30 minutes)

As the number of fermion fields is increased, gauge theories are expected to undergo a transition from a QCD-like phase, characterised by confinement and chiral symmetry breaking, to a conformal phase, where the theory becomes scale-invariant at large distances. In this paper, we discuss some properties of a third phase, where spontaneously broken conformal symmetry is characterised by its Goldstone boson, the dilaton. In this phase, which we refer to as conformal dilaton phase, the massless pole corresponding to the Goldstone boson guarantees that the conformal Ward identities are satisfied in the infrared despite the other hadrons carrying mass. In particular, using renormalisation group arguments in Euclidean space, we show that for massless quarks the trace of the energy momentum tensor vanishes on all physical states as a result of the fixed point.

Presenter: DEL DEBBIO, Luigi (University of Edinburgh)

Session Classification: Senior Session

Contribution ID: **73** Type: **not specified**

Light-meson leptonic decay rates from lattice QCD+QED calculations

Thursday, February 16, 2023 3:40 PM (20 minutes)

The decreasing uncertainties in theoretical predictions and experimental measurements of several hadronic observables related to weak processes, which in many cases are now smaller than O(1%), require theoretical calculations to include subleading corrections that were neglected so far. Precise determinations of leptonic and semi-leptonic decay rates, including QED and strong isospin-breaking effects, can play a central role in solving the current tensions in the first-row unitarity of the CKM matrix. In this talk we discuss the recent progress on lattice calculations of isospin-breaking corrections to leptonic decay rates of pseudoscalar mesons, presenting new results by the RBC/UKQCD collaboration. The inclusion of long-distance QED interactions on the lattice, evaluated using the $\mathrm{QED_L}$ prescription, produces sizeable finite-volume corrections. The relevant role of these effects in the high-precision determination of leptonic decay rates will be discussed, along with prospects for future improvement.

Presenter: DI CARLO, Matteo (University of Edinburgh)

Session Classification: Young Researchers Session

Contribution ID: **74** Type: **not specified**

A novel phenomenological approach to radiative leptonic Bs-meson decays

Thursday, February 16, 2023 9:30 AM (20 minutes)

The LHCb collaboration has recently set a first limit on the radiative leptonic decay of the B_s-meson in the region of high momentum transfer, namely $\mathcal{B}(B_s^0 \to \mu^+\mu^-\gamma)[q^2 > (4.9\,\mathrm{GeV})^2] < 2.0 \times 10^{-9}$. From the theoretical point of view, several computations of the hadronic Form Factors (FFs) entering in this decay are available in the context of quark models and Light Cone Sum Rules methods – with results not always consistent with each other. In this talk, we will present a novel phenomenological approach to the determination of the behaviour of the hadronic FFs in $B_s \to \gamma$ decay, starting from the available LQCD data for $D_s \to \gamma$ decays. The Vector Meson Dominance approximation will be critically investigated in the D_s-sector and our findings will be then extended to the B_s-sector. We will finally use our results to develop a comparison with other determinations of the hadronic FFs and to obtain new SM predictions of the branching ratio and of other observables of interest.

Presenter: VITTORIO, Ludovico (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **75** Type: **not specified**

□□→□□□ decay in the high-□2 region

Thursday, February 16, 2023 10:10 AM (20 minutes)

In this talk, we consider the rare decay channel $B_s \to \mu\mu\gamma$, the radiative counterpart of the very rare $B_s \to \mu\mu$ decay, from both theoretical and experimental perspectives. This decay is sensitive to possible new vector couplings in the $b \to s\mu\mu$ interaction vertex. Using different form factors parametrizations of the $B_s \to \gamma$ transition, we study the differential and integrated branching fractions in the region of high invariant dimuon mass. Additionally, we consider the effective lifetime of $B_s \to \mu\mu\gamma$ as a new observable, sensitive to non-SM-like CP violation. In addition, we present the first experimental search of this channel in LHCb, through a partial reconstruction method, and we discuss the possibilities of improving and extending this measurement in Run 2 data, and the prospects using the upcoming Run 3 data.

Presenter: NORMAND, Camille (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **76** Type: **not specified**

Elementary particle mass generation without Higgs

Thursday, February 16, 2023 2:50 PM (30 minutes)

We discuss how a recently discovered non-perturbative field-theoretical mechanism giving mass to elementary fermions can be extended to generate a mass for the electro-weak bosons, when weak interactions are introduced, and can thus be used as a viable alternative to the Higgs scenario. We will show that this new scheme, successfully tested in extensive lattice simulations, offers a solution of the Higgs mass naturalness problem (as there is no Higgs around), an understanding of the fermion mass hierarchy (as related to the ranking of gauge couplings), a physical interpretation of the electro-weak scale (as the scale of a new super-strong interaction) and unification of gauge couplings (without supersymmetry).

Presenter: ROSSI, Giancarlo (University of Roma Tor Vergata, INFN Roma2 and Centro Fermi)

Session Classification: Senior Session

Contribution ID: **78** Type: **not specified**

The landscape of QCD axion models

Friday, February 17, 2023 9:40 AM (30 minutes)

Four decades after its prediction the axion remains the most compelling solution to the strong CP problem and a well motivated dark matter candidate, inspiring several ultrasensitive experiments based on axion-photon mixing. After reviewing the axion solution to the strong CP problem, I will focus on recent developments in axion model building suggesting that the QCD axion parameter space is much larger than what traditionally thought. The implications for astrophysical limits and future experiments will be discussed as well.

Presenter: DI LUZIO, Luca

Session Classification: Senior Session

Contribution ID: **79** Type: **not specified**

A Visible QCD Axion Portal to GeV Scale Dark Matter

Friday, February 17, 2023 12:10 PM (20 minutes)

We consider a model involving a "visible"QCD axion with mass in the MeV range with flavour non-universal couplings to the Standard Model (SM) first generation fermions. Such a heavy axion must evade a variety of stringent constraints which precisely fix the couplings to the SM fields: the requirement of "pion-phobia"determines the Peccei-Quinn (PQ) charges of the light quarks to be 2/3 and 1/3 for the up and down quarks, respectively, while the precise measurement of the electron's anomalous magnetic moment, combined with collider and beam dump constraints, require the PQ charge of the electron to be O(1). By letting the axion also couple to a Dark Matter (DM) fermion ⊠, we solve the Boltzmann equations to find the regions of the parameter space that yield the correct relic abundance. The coupling of the DM with the electrons is subject to indirect detection constraints from the CMB, while those with the light quarks induce elastic DM-nucleus collisions that are subject to nuclear recoil constraints. This restricts the allowed region of the parameter space that reproduces the correct relic abundance to the GeV mass range and PQ charges of O(0.1).

Presenter: ARMANDO, Giovanni (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Contribution ID: **80** Type: **not specified**

Photon fusion and tau g-2 measurements in ATLAS

Friday, February 17, 2023 2:00 PM (30 minutes)

High-statistics measurements in peripheral photon-induced scattering using relativistic heavy-ion beams provide a precise and unique opportunity to investigate extensions of the Standard Model. New measurements of exclusive dilepton production (electron, muon, and tau pairs) are discussed. In particular, the tau-pair production measurement is used to constrain tau lepton's anomalous magnetic dipole moment which is experimentally much less constrained compared to the electron or muon magnetic moments. In addition, the measurement of light-by-light scattering and the search for axion-like particles will be discussed.

Presenter: VERDUCCI, Monica (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **81** Type: **not specified**

QCD Axion vs Lattice QCD: Past successes and future challenges

Friday, February 17, 2023 10:40 AM (30 minutes)

I will overview the interplay between QCD axion properties and Lattice QCD inputs and discuss open questions in axion phenomenology and cosmology.

Presenter: VILLADORO, Giovanni

Session Classification: Senior Session

Contribution ID: **82** Type: **not specified**

The cosmic evolution of the QCD axion, and lattice simulations

Friday, February 17, 2023 11:10 AM (30 minutes)

Ab-initio results from QCD topological susceptibility as a function of temperature constrain the freeze-out of the QCD axion, and in turn limit the available parameter space of today's axion coupling and mass. The talk reviews the status of lattice studies, with emphaysis on extrapolation to the relevant temperarure range. Issues related with the continuum limit of lattice results with physical quark masses are discussed as well.

Presenter: LOMBARDO, Maria Paola

Session Classification: Senior Session

Contribution ID: **83** Type: **not specified**

Axion hot dark matter bound, reliably

Friday, February 17, 2023 12:30 PM (20 minutes)

Axions originally emerged as low-energy remnants of the Peccei-Quinn solution to the strong CP problem. They also unavoidably contribute to the energy density of the Universe, quantified via the effective number of relativistic degrees of freedom (Δ□□□□), which is constrained by cosmic microwave background experiments.
In the talk, I will discuss the main axion-thermalization channel in the early universe at temperatures below that of the QCD phase transition, namely the axion-pion scattering, within the 2-flavor chiral perturbation theory (ChPT). Based on the leading order (LO) ChPT, the bound on the axion mass from Δ□□□□ is found to be approximately below the eV scale. However, considering the impact of NLO corrections, I will show that the perturbative chiral expansion breaks down for temperatures above 70 MeV, making the LO analysis not reliable. I will also discuss how to extend the EFT validity via unitarization techniques up to the deconfinement temperature, providing a reliable determination of the relic density of thermal axions decoupling after the QCD phase transition.

Presenter: PIAZZA, Gioacchino

Session Classification: Young Researchers Session

Contribution ID: **84** Type: **not specified**

Nonresonant Searches for Axion-Like Particles in Vector Boson Scattering Processes at the LHC

Friday, February 17, 2023 3:20 PM (20 minutes)

We propose a new search for Axion-Like Particles (ALPs), targeting Vector Boson Scattering (VBS) processes at the LHC. We consider nonresonant ALP-mediated VBS, where the ALP participates as an off-shell mediator. This process occurs whenever the ALP is too light to be produced resonantly, and it takes advantage of the derivative nature of ALP interactions with the electroweak Standard Model bosons. We study the production of , , $^{\pm}$, $^{\pm}$ and $^{\pm\pm}$ pairs with large diboson invariant masses in association with two jets. Working in a gauge-invariant framework, upper limits on ALP couplings to electroweak bosons are obtained from a reinterpretation of Run 2 public CMS VBS analyses. The constraints inferred on ALP couplings to , and $^{\pm\pm}$ pairs are very competitive for ALP masses up to 100 GeV. They have the advantage of being independent of the ALP coupling to gluons and of the ALP decay width. Simple projections for LHC Run 3 and HL-LHC are also calculated, demonstrating the power of future dedicated analyses at ATLAS and CMS.

Presenter: MACHADO RODRÍGUEZ, Jonathan (Instituto de Física Teórica - UAM)

Session Classification: Young Researchers Session

Contribution ID: **86** Type: **not specified**

A new renormalizable model for ALP dark matter and its phenomenology

Friday, February 17, 2023 3:40 PM (20 minutes)

Axion-like particle (ALP) is one of the promising candidates of dark matter (DM). It can emerge from the dark sector with global U(1) symmetry. It is often (implicitly) assumed that the dark sector has a CP symmetry. However, since CP is violated within the SM, the dark sector with CP violation is also an interesting possibility. In this talk, we propose a new renormalizable model for ALP with CP violation in the dark sector. We discuss the properties of the predicted ALP and how the ALP can be probed in future collider experiments.

Presenter: SAKURAI, Kodai (University of Warsaw)

Session Classification: Young Researchers Session

Contribution ID: **88** Type: **not specified**

Muon g-2 from the BMW collaboration

Wednesday, February 15, 2023 5:10 PM (30 minutes)

We present our previous and ongoing lattice QCD efforts to determine thehadron vacuum polarization contribution to the muon magnetic moment.

Presenter: SZABO, Kalman (University of Wuppertal)

Session Classification: Senior Session

Contribution ID: **89** Type: **not specified**

Axion-like particles as mediators for dark matter: beyond freeze-out

Friday, February 17, 2023 3:00 PM (20 minutes)

Recent experimental advances now severely constrain electroweak-scale WIMPs produced via thermal freeze-out, leading to a shift away from this standard paradigm. Here we consider an axion-like particle (ALP), the pseudo-Goldstone boson of an approximate $U(1)$ global symmetry spontaneously broken at a high scale f_a, as a mediator between the Standard model (SM) particles and the dark matter (DM) particles. We explore the case where the couplings are too small to allow for DM generation via freeze-out and the mediator particle and the DM constitute a hidden sector which is thermally decoupled from the SM particles. However, alternative generation mechanisms such as freeze-in and decoupled freeze-out are now appropriate. Having determined the region of parameter space where the correct relic density is obtained, we then revisit experimental constraints on ALPs from electron beam dump experiments, astrophysics, rare B and K decays and cosmology.

Presenter: MUTZEL, Sophie

Session Classification: Young Researchers Session

Contribution ID: **94** Type: **Oral presentation**

The status of the MEGII experiment

Thursday, February 16, 2023 12:20 PM (20 minutes)

Since the observation of neutrino oscillations, lepton number conservation is known to be a non-exact symmetry of the Standard Model lagrangian: yet there is still no evidence of lepton flavour violating processes involving charged leptons (cLFV), such as $\rightarrow e$, $\rightarrow eee$ or $\rightarrow eN$: according to minimal extensions of the Standard Model including neutrino masses, these processes are too rare to be observed experimentally (e.g. $BR(\rightarrow) \sim \mathcal{O}(10^{-55})$). Nontheless, after more than 70 years of research the effort to observe these phenomena continues because any experimental observation would be a clear evidence of Physics beyond the Standard Model and most New Physics scenarios awaits for a positive result just below the current sensitivity limits.

Between these new experiments shines MEGII @Paul Scherrer Institut, designed to overtake the current measurement of
$BR(+ \rightarrow e +)$ 4.2×10^{-13} (MEG 2016), with a predicted sensitivity of $6\times10-14$ (three years of data taking). MEGII experiment works in the following way: $^{+}$ of 28MeV/c are stopped on a thin plastic target at the center of a detector system designed to detect the products of the two-body $\rightarrow e$ decay, i. e. a coincident signal from anti-parallel e^{+} and with fixed energy ($\simeq 52.8$ MeV). To achieve a sensitivity of 6×10^{-14}, the experiment exploits the most intense muon beam in the world (up to $108\ ^{+}/s$) as well as newly conceived particle detectors to reduce background contamination and to improve the resolution of the particles' kinematic properties: the photon detector is a 900 l liquid Xenon detector instrumented with more than 4000 SiPM and hundreds of phototubes; the spectrometer to track the positron is composed of a ultra-light (1.58×10^{-30}) and ultra-segmented (more than 1700 signal wires) cylindrical drift chamber, a highly segmented detector with scintillating tiles read by SiPM. These detectors are immersed in a non-solenoidal magnetic field.
Auxiliary detectors help to improve the background rejection.
A trigger and data acquisition system WaveDAQ allows to digitize the waveforms from each of the ~ 9000 detector channels for offline event reconstruction, while simultaneously rejecting most of the background events: the event rate is reduced from 10^{7} Hz down to 10 Hz while keeping a 97 % selection efficiency.

Currently, MEGII has ended its second year of data acquisition.
In this presentation In will review MEG~II's experimental concept and status.

Primary author: VENTURINI, Antoine (Istituto Nazionale di Fisica Nucleare)

Presenter: VENTURINI, Antoine (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Researchers Session

Track Classification: CKM & LFU

Contribution ID: **102** Type: **not specified**

Status and recent updates on experimental searches for axions and Axion-Like Particles at B factories

Friday, February 17, 2023 9:10 AM (30 minutes)

Axions and Axion-Like Particles (ALPs) are hypothetical particles that could help solve the strong QCD problem and/or act as dark matter or dark portals. B factories are high-precision experiments specialized in B physics, but also exceptionally capable of probing the dark matter MeV-to-GeV range. In this talk, I will report on the status and the recent results of searches for axions and ALPs at the past B factories, BaBar and Belle, and the current, second-generation Belle II.

Presenter: DE NUCCIO, Michael

Session Classification: Senior Session

Contribution ID: **103** Type: **not specified**

Accidental Peccei-Quinn symmetry and composite axions from chiral gauge theories

Friday, February 17, 2023 2:30 PM (30 minutes)

The axion solution to the strong CP problem is known to be sensitive to Planck scale effects, that give rise to the axion quality problem. We study a class of chiral gauge theories with a confining vector-like SU(N) factor and a weakly interacting chiral U(1) in which the Peccei-Quinn (PQ) symmetry is accidental and the axion arises as a composite Nambu-Goldstone boson. We clarify the selection rules under which higher-dimensional PQ-violating operators can generate a potential for the axion in the IR, and find analytically the general solution over the integers to the U(1) anomaly equations. These results, of more general validity, allow us to identify and classify the models with an high quality PQ symmetry, protected up to operators of dimension 12, 15 or 18 depending on the charge assignments, irrespectively of the Planck scale dynamics. Our framework is compatible with a unified dynamics for the Standard Model sector, and we highlight the phenomenological signatures of such a scenario.

Presenter: PODO, Alessandro

Session Classification: Senior Session

Contribution ID: **106** Type: **not specified**

Experimental approaches in the search for low mass axion-like particles

Friday, February 17, 2023 11:40 AM (30 minutes)

Presenter: LAMANNA, Gianluca (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **107** Type: **not specified**

The muEDM experiment

Thursday, February 16, 2023 4:20 PM (20 minutes)

The Standard Model (SM) of particle physics successfully predicts many fundamental properties and interactions, but it is still incomplete. Models like baryogenesis or leptogenesis for the matter-antimatter asymmetry lead to an additional CP violation beyond the SM. In this context, electric dipole moments (EDMs), which violate time-reversal and parity symmetry, and by virtue of the CPT theorem also CP, can test such scenarios.

Many EDM searches have been concluded with increasing sensitivity, all with null results. But the most exciting hints for BSM physics appeared in several precision measurements involving muons. These hints for new physics suggest a flavour structure beyond minimal flavour violation (MFV) in the lepton sector. In MFV a simple scaling by / is predicted, so that the electron EDM (1.1×10^{-29}) would place severe limits on its muon counterpart. This relation does not hold in theories with a flavour structure beyond the MFV paradigm, allowing for a sizable muon EDM.

The muEDM experiment, using for the first time the "frozen-spin" technique in a compact storage ring, aims at improving the current direct experimental limit of $< 1.5\times10^{-19}$ of the muon EDM reaching a final precision of better than 6×10^{-23} and testing the intrinsic connection of the muon EDM with –2. Given the complexity of the experiment, Phase I will be proof of concept and will reach a sensitivity of 3×10^{-21}.

Presenter: VITALI, Bastiano

Session Classification: Young Researchers Session

Contribution ID: **109** Type: **not specified**

B-anomalies in non-universal models

Thursday, February 16, 2023 12:40 PM (20 minutes)

An attractive explanation for the flavor puzzle of the Standard Model is the multi-scale origin of the flavor hierarchies, where the size of the Standard Model Yukawas of the different families is associated to different scales. This solution makes more natural the tight flavor bounds for New Physics at the TeV scale, and can accommodate possible B-anomalies. I will discuss the status and prospects of B-anomalies in this context and other related observables.

Presenter: M. LIZANA, Javier

Session Classification: Young Researchers Session

Contribution ID: **110** Type: **not specified**

Lattice determination of the spectral function for $D_s \to \ell\nu_\ell\gamma^*$ decays

Thursday, February 16, 2023 11:50 AM (30 minutes)

We discuss a novel approach, based on spectral reconstruction techniques, which circumvents the well-known problem of the analytic continuation from Minkowskian to Euclidean time for hadronic processes above kinematical thresholds. The approach is discussed for the specific case of the radiative decays of pseudoscalar mesons $P \to \ell\nu_\ell\gamma$, where γ is a virtual photon.
These processes, which give access to the rare decays $P \to \ell\nu_\ell\bar{\ell}'\ell'$, are notoriously difficult to study on
the lattice due to the presence of intermediate states which hinder the analytic continuation to Euclidean time when the photon off-shellness $\sqrt{k^2}$ is larger than the invariant mass of the lightest intermediate state. We apply the new spectral reconstruction method to the decay $D_s \to \ell\nu_\ell\gamma^*$ and present some preliminary results.

Presenter: GAGLIARDI, Giuseppe (Istituto Nazionale di Fisica Nucleare)

Session Classification: Senior Session

Contribution ID: **112** Type: **Poster session**

Topological properties of CP^{N-1} models

Thursday, February 16, 2023 7:00 PM (1h 30m)

The study of non-perturbative properties characterizing Quantum Chromo-Dynamics (QCD) is of relevant theoretical and phenomenological interest. Indeed, the θ-dependence of QCD is related to open issues such as the strong-CP violation or to the Peccei-Quinn axion physical properties. The lattice approach is a natural first-principle tool to investigate the non-perturbative properties of gauge theories and it has proven to be very successful in the study of the topological properties of QCD. For this reason, in the literature there are many numerical works dedicated to the study of simpler toy models as a test-bed for new algorithms and numerical methods for the study of gauge theories.
An example is provided by the $2d$ CP^{N-1} models, which share many properties with QCD, such as asymptotic freedom, confinement, instantons and θ-dependence. A peculiarity of the CP^{N-1} models emerges in the $N \to 2$ limit. In the case of CP^1, which can be exactly mapped into the $O(3)$ σ-model, the semi-classical picture predicts the divergence of the topological susceptibility, due to the dominance of instantons of arbitrarily small size. Detecting this divergence by numerical lattice simulations is not an easy task, because it is logarithmic in the lattice spacing.
We address the problem from a new original perspective: we study the behavior of the model when the volume is fixed in dimensionless lattice units, where perturbative predictions are turned into more easily checkable behaviors. After testing this strategy for $N = 3$ and 4, we apply it to $N = 2$, adopting at the same time a multicanonic algorithm to overcome the problem of rare topological fluctuations on asymptotically small lattices. Our final results fully confirm, by means of purely non-perturbative methods, the divergence of the topological susceptibility of the $2d$ CP^1 model.

Primary authors: BONANNO, Claudio (INFN Firenze); MARGARI, Francesca; D'ELIA, Massimo (Istituto Nazionale di Fisica Nucleare)

Presenter: MARGARI, Francesca

Session Classification: Poster Session and Discussion Session

Contribution ID: **113** Type: **Poster session**

Hadronic contribution to the running of the fine structure constant

Thursday, February 16, 2023 7:00 PM (1h 30m)

The electromagnetic coupling constant, α, is one of the fundamental parameters of the Standard Model (SM). Its value at the Z boson mass, $\alpha(M_Z)$, is of particular interest as it enters EW precision tests. When running α from low energies up to the Z mass, five orders of magnitude in precision are lost. This makes it one of the least well determined parameters of the SM at that scale. The largest source of error comes from non-perturbative hadronic effects in the low energy region.

These non-perturbative effects can be determined from ab-initio calculations on the lattice. We present preliminary lattice results for the leading order hadronic contribution to this running at different values of Q^2, the four-momentum transfer squared. These are obtained using simulations with 2+1+1 flavors of staggered fermions at physical values of the quark masses.

Presenter: MUTZEL, Sophie

Session Classification: Poster Session and Discussion Session

Contribution ID: **114** Type: **Poster session**

Lepton flavour violating $\Sigma_b \to \Sigma l_1 l_2$ decays in Z' model

Thursday, February 16, 2023 7:00 PM (1h 30m)

Inspired by the various LHCb results of lepton flavour violation on $b \to s$ transition we will study the lepton flavour violating $\Sigma_b \to \Sigma l_1 l_2$ decays in terms of transversity amplitudes in non-universal Z' model. These LFV processes are extremely suppressed in the Standard Model (SM) because the expected levels at the SM lie far below current experimental sensitivities. In particular the branching fractions of $B^0 \to \tau^{\pm}\mu^{\mp}$ and $B_s \to \tau^{\pm}\mu^{\mp}$ decays are obtained in SM of order 10^{-54} [1] whereas experimentally they are constrained at the order of 10^{-5} by BaBar and LHCb with 90% and 95% confidence level respectively [2, 3]. There are several theoretical models proposed to explain various popular anomalies of b hadron sector. It can be said that the models that generate LFU violation also can generate LFV processes. Various lepton flavour violating decays, such as $\tau \to 3\mu$, $\mu \to 3e$, $l \to l\ M$ (where l, l' are different leptons and M is meson) and radiative decays $\mu \to e\gamma$ etc are studied in different NP models [4, 5] though there are no direct experimental evidence of these decays but their experimental bounds exist. In this work we will study the differential branching fractions of LFV decays $\Sigma_b \to \Sigma l_1 l_2$ induced by the quark level transition $b \to s l_1 l_2$ in Z' model where l_1 and l_2 are charged leptons of different flavours. We will constrain the NP couplings using several experimental upper limits. It is expected that the study of the decay would be very interesting and that might emboss the footprints of NP more aesthetically.

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Primary authors: CHAKRABARTY, RAJESH (NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR); BISWAS, SWAGATA (NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR)

Presenter: CHAKRABARTY, RAJESH (NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR)

Session Classification: Poster Session and Discussion Session

Contribution ID: **115** Type: **Poster session**

Longitudinal polarization asymmetry of Ξ_b decays with the effect of non-universal Z' boson

Thursday, February 16, 2023 7:00 PM (1h 30m)

Rare baryonic decays induced by flavour changing neutral current (FCNC) have been of immense interest in recent years because of their sensitivities towards new physics (NP) beyond the standard model (SM). The exploration had been triggered with the observation of $\Lambda_b \to \Lambda\mu^+\mu^-$ transition at the Fermilab [1] and the LHCb [2]. Theoretically these decays are also studied at different NP models [3-5]. Inspired by these results obtained for baryonic decays [3-7], we are interested to study the polarization asymmetry for Ξ_b baryon with the effect of NP. Various theoretical studies of branching fractions for $\Xi_b \to \Xi l^+ l^-$ decays in the standard model (SM) [8] proclaim the possibility of observation of these decays at the LHC. In this work, we will mainly concentrate on longitudinal polarization asymmetries for muonic, electronic and taunic channels in family non-universal Z' model [9, 10]. Asymmetry parameters characterize the angular dependence of differential decay width with polarized and unpolarized heavy baryons. We will investigate the observables with the contribution of Z' boson. The phenomenology of Z' is one of the important sectors to the accelerators. Due to its heavy mass, it may be used to calibrate the upcoming runs of the experiments. Here, we will introduce the NP couplings and use their constrained values. We will show the variation of the observables throughout the whole allowed kinematic region. These results for Ξ_b decays will help the experimental community to observe the decays in colliders and will unlock a new horizon to the theoretical community to probe NP with heavy baryons.

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Presenter: BISWAS, SWAGATA (NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR)

Session Classification: Poster Session and Discussion Session

Contribution ID: **116** Type: **Poster session**

Impact of High Scale New Physics on CP Violating and Flavor Changing Quark Dipole Transitions

Thursday, February 16, 2023 7:00 PM (1h 30m)

We explore the CP-violating (CPV) effects of heavy New Physics in the flavour-changing quark dipole transitions, within the framework of Standard Model Effective Field Theory (SMEFT). We connect the operators defined at the heavy scale Λ with the low energy observable via the Renormalisation Group (RG) evolution of the appropriate Wilson coefficients. We investigate RG-induced correlations between different flavour-violating processes and electric dipole moments (EDMs) within the Minimal Flavour Violating and $U(2)^3$ quark flavour models. We present bounds on the Wilson coefficients of the dipole operators at the high scale $\Lambda = 5\ TeV$ from CPV induced contributions to observables in non-leptonic and radiative B, D and K decays as well as the neutron and electron EDMs. This can guide experimental searches to focus on more sensitive observables.

Primary author: TAMMARO, Michele (Jozef Stefan Institute)

Presenter: TAMMARO, Michele (Jozef Stefan Institute)

Session Classification: Poster Session and Discussion Session

Contribution ID: **117** Type: **Poster session**

Lepton number and lepton flavour violation searches in B decays at LHCb

Thursday, February 16, 2023 7:00 PM (1h 30m)

In the Standard Model of particle physics, lepton flavour and lepton number are conserved quantities, although there is no fundamental symmetry associated with their conservation and lepton flavour violation has been already confirmed by the observation of neutrino oscillations.
Many lepton flavour violating (LFV) and lepton number violating (LNV) processes can be searched for in B meson decays and the LHCb experiment plays a very important role in this sector. The observation of charged LFV or LNV decays would be a clear sign of new physics beyond Standard Model.
The most recent results of searches for LFV and LNV B meson decays at LHCb are presented in the talk. In addition, possible perspectives on this topic, such as searches for heavy neutral leptons, will be discussed.

Primary author: FANTINI, Lisa (Istituto Nazionale di Fisica Nucleare)

Presenter: FANTINI, Lisa (Istituto Nazionale di Fisica Nucleare)

Session Classification: Poster Session and Discussion Session

Contribution ID: **118** Type: **Poster session**

Beam Dynamics Studies for the Muon g-2 experiment at Fermilab

Thursday, February 16, 2023 7:00 PM (1h 30m)

The main goal of the Fermilab Muon g-2 experiment is to determine the muon anomalous magnetic moment (a_μ) to a 140 parts per billion (ppb) uncertainty, to compare it with the Standard Model prediction. The value of a_μ is determined by measuring two quantities: the anomalous spin precession frequency of positive muons circulating in a storage ring and the magnetic field experienced by the stored muons. In 2021, the collaboration published the first result with ~6% of the final statistics and a total uncertainty of 462 ppb dominated by the statistical contribution. This result is in agreement with the previously published measurement obtained at Brookhaven National Laboratory (BNL); the combination of the two results disagrees by 4.2 standard deviations with the most accurate theoretical prediction published in 2020 and by 1.5 standard deviations with the calculation that uses Lattice QCD results. To achieve the final uncertainty goal, the muon beam dynamics, from injection to storage until all muons decay, has to be fully under control. This poster, after describing the experimental technique, presents preliminary work on beam dynamics systematic studies using experimental data and simulation.

Presenter: HESS, Emma (Istituto Nazionale di Fisica Nucleare)

Session Classification: Poster Session and Discussion Session

Contribution ID: **119** Type: **Poster session**

Multi-Objective Genetic Optimization for the High-Intensity Muon Beams at PSI

Thursday, February 16, 2023 7:00 PM (1h 30m)

The High-Intensity Muon Beams (HIMB) project aims to increase the rate of the intensity muon beamlines at Paul Scherrer Institute (PSI) by two orders of magnitude up to 10^10 μ+/s, with a significant impact on low-energy, high-precision muon-based experiments. This is done by improving the surface muon yield with a new target geometry and by increasing capture and transmission with solenoid-based beamlines.

Even though the project focuses on surface muons, the increased capture and transmission affect all the particle species produced at target. The beamlines will be able to deliver muons, electrons and pions, and it is essential to evaluate the deliverable beam characteristics of all the particle species in the full momentum range accepted by the dipoles, up to 80 MeV/c.

To evaluate the performances of the beamlines, we rely on particle tracking simulations in high-fidelity field maps, which are computationally intensive and time-expensive to optimize. The optimization of the relevant beam parameters is performed with Multi-Objective Genetic Algorithms (MOGA), as they have been proved efficient in solving high-dimensional global optimization problems.

We present here the optimization strategy of the HIMB beamlines based on MOGA and its results.

Primary authors: DAL MASO, Giovanni (Paul Scherrer Institut - ETH Zürich); FOR THE HIMB PROJECT

Presenter: DAL MASO, Giovanni (Paul Scherrer Institut - ETH Zürich)

Session Classification: Poster Session and Discussion Session

Contribution ID: **120** Type: **Poster session**

The search for the X17 particle with the MEG-II apparatus

Thursday, February 16, 2023 7:00 PM (1h 30m)

The angular correlation distribution of electron-positron pairs from Internal Pair Conversion emitted by excited 8Be and 4He nucleus was measured by ATOMKI. Over the expected monotonically decreasing trend was measured a significant excess which can be interpreted as the production of a hypothetical particle (X17) whose mass is around 17 MeV.

The MEG-II experiment at the Paul Scherrer Institute searches for the lepton flavour violating decay $\mu \to e\gamma$. Its apparatus has the capability to reproduce the ATOMKI measurements in order to confirm or deny such excess in an independent manner. A Cockroft-Walton accelerator is used to send 1 MeV protons on a thin lithium target in order to produce 8Be by proton capture. The 7Li(p,e+e−)8Be process can be studied with a system composed a cylindrical drift chamber and fast scintillators immersed into a magnetic field, aiming at a better invariant mass resolution than the previous experiment.

A first data-taking period was conducted in 2022 and a second one is scheduled for 2023. We report here the first results on the analysis of 2022 data.

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Session Classification: Poster Session and Discussion Session

Contribution ID: **121** Type: **Poster session**

The muEDM experiment

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The Standard Model (SM) of particle physics successfully predicts many fundamental properties and interactions, but it is still incomplete. Models like baryogenesis or leptogenesis for the matter-antimatter asymmetry lead to an additional CP violation beyond the SM. In this context, electric dipole moments (EDMs), which violate time-reversal and parity symmetry, and by virtue of the CPT theorem also CP, can test such scenarios.

Many EDM searches have been concluded with increasing sensitivity, all with null results. But the most exciting hints for BSM physics appeared in several precision measurements involving muons. These hints for new physics suggest a flavour structure beyond minimal flavour violation (MFV) in the lepton sector. In MFV a simple scaling by m_μ/m_e is predicted, so that the electron EDM ($d_e \leq 1.1 \times 10^{-29} e \cdot cm$) would place severe limits on its muon counterpart. This relation does not hold in theories with a flavour structure beyond the MFV paradigm, allowing for a sizable muon EDM.

The muEDM experiment, using for the first time the "frozen-spin" technique in a compact storage ring, aims at improving the current direct experimental limit of $d_\mu < 1.5 \times 10^{-19} e \cdot cm$ of the muon EDM reaching a final precision of better than $6 \times 10^{-23} e \cdot cm$ and testing the intrinsic connection of the muon EDM with g–2. Given the complexity of the experiment, Phase I will be proof of concept and will reach a sensitivity of $3 \times 10^{-21} e \cdot cm$.

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