Polish Particle and Nuclear Theory Summit (2PiNTS) 2024

Report of Contributions

https://indico.ifj.edu.pl/e/2pints2024

Contribution ID: **37** Type: **Talk**

Crossing the desert: Towards predictions for SMEFT coefficients from quantum gravity

Thursday, 12 September 2024 14:20 (20 minutes)

The SMEFT provides a general framework to search for new physics beyond the current reach of direct detection. One such form of new physics is quantum gravity. Based on dimensional analysis, one would expect the prediction that the quantum-gravity contribution to the SMEFT coefficients is unmeasurably tiny at LHC scales. In this paper, we test this expectation in a specific framework for quantum gravity, namely the asymptotic safety framework. In this framework, Wilson coefficients can be calculated in relatively straightforward manner, making a connection between quantum gravity and LHC tests of the SMEFT achievable. We work in a toy model of the Standard Model fermion sector to investigate four-fermion couplings. We find three scenarios in this toy model, based on three distinct fixed points of the Renormalization Group flow. In the first scenario, the expectation from dimensional analysis is borne out and Wilson coefficients are Planck-scale suppressed. In the second and third scenarios, the Wilson coefficients are significantly larger than expected by dimensional analysis, due to interacting fixed points which generate an effective new-physics scale that lies between the LHC scale and the Planck scale. We comment on the implications of these results for the testability of asymptotically safe gravity within the SMEFT framework at the LHC.

Primary authors: CHIKKABALLI, Abhishek (NCBJ, Warsaw); Prof. EICHHORN, Astrid (University of Southern Denmark, Odense); Prof. BRENNER, Lydia (Nikhef, Amsterdam); Dr RAY, Shouryya (University of Southern Denmark, Odense)

Presenter: CHIKKABALLI, Abhishek (NCBJ, Warsaw)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **38** Type: **Talk**

Freezing-in Cannibal Dark Sectors

Thursday, 12 September 2024 13:40 (20 minutes)

Self-Interacting Dark Matter models offer a compelling framework for explaining dark matter production through interactions confined within the dark sector. Introducing a feeble coupling between the dark and visible sectors via a Higgs portal not only opens up new avenues for detection and enriches thermal production dynamics but also provides a potential explanation for the initial dark matter population via the freeze-in mechanism. In this talk, I will examine the freeze-in production of dark matter in scenarios involving self-interactions, focusing on two cases: one with a dark sector consisting solely of unstable dark matter, and another with stable dark matter and an unstable scalar mediator. I will emphasize how variations in dark sector interactions can either tighten or relax cosmological constraints, leading to distinct signatures in long-lived particle searches and indirect detection experiments.

Primary authors: Mr HRYCZUK, Andrzej (NCBJ (Warsaw)); Mr CERVANTES HERNANDEZ, Juan Esau (NCBJ (Warsaw))

Presenter: Mr CERVANTES HERNANDEZ, Juan Esau (NCBJ (Warsaw))

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **39** Type: **Talk**

Entropy production and dissipation in spin hydrodynamics

Friday, 13 September 2024 13:30 (20 minutes)

Motivated by the evidence of spin polarization in particles produced by relativistic heavy ion collisions, there is growing interest in the so-called relativistic spin hydrodynamics. In this talk, we will present the outcomes of using first-principle quantum-statistical methods to derive the expression for the entropy production rate in relativistic fluids composed of particles with spin. Based on this, we will discuss our ongoing development of a novel method for deriving various dissipative currents in the system.

Ref: [Phys.Lett.B 850 (2024) 138533]

Primary author: DAHER, Asaad (IFJ PAN Krakow)

Presenter: DAHER, Asaad (IFJ PAN Krakow)

Session Classification: ECR

Track Classification: Nuclear Physics [Early Career]

Contribution ID: **40** Type: **Talk**

Functional renormalisation of UV-safe gauge theories coupled to matter

Thursday, 12 September 2024 13:20 (20 minutes)

Certain types of large-N gauge theories coupled to matter offer interacting UV fixed points that are under strict perturbative control, beyond the paradigm of asymptotic freedom. In this work, we derive and investigate functional RG equations for the quantum effective potential of the theory to leading order in a derivative expansion. We thereby find the RG flows, fixed points, and scaling dimensions of infinitely many canonically irrelevant interaction monomials to leading order in the small Veneziano parameter. We also find that results can be resummed into closed expressions. Implications for vacuum stability and the size of the conformal window, links with RG studies in the MS bar scheme, and extensions towards larger Veneziano parameters are indicated.

Primary authors: LITIM, Daniel (University of Sussex (GB)); RIZZO, Daniele (National Center for Nuclear Research (NCBJ), Warsaw, Poland)

Presenter: RIZZO, Daniele (National Center for Nuclear Research (NCBJ), Warsaw, Poland)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **41** Type: **Talk**

Kink behavior in the sine-Gordon model under a variety of inhomogeneities

Thursday, 12 September 2024 14:40 (20 minutes)

Our research focuses on an extensive analysis of the dynamics of kink solutions in a modified sine-Gordon model, including a comprehensive study of the effects of breaking translational invariance due to the presence of periodic and localized inhomogeneities.

We present a significant advancement in understanding the behavior of kink solutions within the sine-Gordon model, particularly in these complex environments. By introducing a novel ansatz, we have successfully constructed an effective model with two degrees of freedom. This model achieves remarkable accuracy in predicting the kink's dynamics, even in the non-perturbative regime and at relativistic velocities. The effectiveness of our model was validated through comprehensive numerical simulations, which demonstrated excellent agreement with the original partial differential equations. We also emphasize the critical influence of initial conditions on the accuracy of the effective model, offering new insights into the interaction between kinks and heterogeneous environments.

Furthermore, we explore the dynamics of kinks under additional influences, such as a switched bias current and dissipation, within environments featuring periodic heterogeneity. Our findings suggest that the effective model not only captures the kink's position and width evolution with high precision but also offers potential for manipulating the kink's trajectory and rest position through external controls. This capability could lead to innovative techniques for controlling non-linear wave dynamics in various physical systems. The successful application of this approach to more complex environments underscores its robustness and opens new avenues for exploring kink dynamics in other non-integrable Klein-Gordon models and beyond.

The collective findings from our studies not only advance the understanding of kink dynamics in complex media but also pave the way for future research in the domain of non-linear wave motions in dispersive systems. The methodologies and results presented in this talk are anticipated to stimulate further investigations, potentially leading to novel applications in fields ranging from condensed matter physics to applied mathematics and engineering.

References

[1] J. Gatlik and T. Dobrowolski, *Modeling kink dynamics in the sine–Gordon model with position dependent dispersive term*, Physica D, **428**, 133061 (2021).
[2] J. Gatlik and T. Dobrowolski, *The impact of thermal noise on kink propagation through a heterogeneous system*, Physica D, **445**, 133649 (2023).
[3] J. Gatlik, T. Dobrowolski, and P. G. Kevrekidis, *Kink-inhomogeneity interaction in the sine-Gordon model*, Phys. Rev. E, **108**, 034203 (2023).
[4] J. Gatlik, T. Dobrowolski, and P. G. Kevrekidis, *An effective description of the impact of inhomogeneities on the movement of the kink front in 2+1 dimensions*, Phys. Rev. E, **109**, 024205 (2024).

Primary authors: Dr GATLIK, Jacek (Faculty of Physics and Applied Computer Science, AGH University of Krakow); Prof. DOBROWOLSKI, Tomasz (Department of Computer Physics and Quantum Computing, University of the National Education Commission in Krakow, Poland); Prof. KEVREKIDIS, Panayotis G. (Department of Mathematics and Statistics, University of Massachusetts, Amherst, USA)

Presenter: Dr GATLIK, Jacek (Faculty of Physics and Applied Computer Science, AGH University of Krakow)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **42** Type: **Talk**

Photon-photon transition form factor for tensor meson quarkonium

Friday, 13 September 2024 13:50 (20 minutes)

We will discuss the light-front formulation of quarkonium $\gamma^*\gamma$ transition
form factors for J PC = 2++ meson states. We will present $\gamma^*\gamma \to \chi c2$ transition amplitudes and the pertinent helicity form factors. We show the results for the two-photon decay width of $\chi c2$ and three independent transition form factors of $\chi c2$ as a function of photon virtuality Q2. We compare our results for the two-photon decay width to the recently measured ones by the Belle-2 and BES III collaborations. Our approach explains the value of $\Gamma(\chi c2)/\Gamma(\chi c0)$ measured experimentally. We also present the off-shell widths as a function of photon virtuality and compare them to the Belle data.
Based on: I.B., et al., JHEP 06 (2024) 159, e-Print: 2402.13910 [hep-ph]

Primary author: BABIARZ, Izabela (Institute of Nuclear Physics Polish Academy of Sciences)

Co-authors: SZCZUREK, Antoni (IFJ PAN); SCHÄFER, Wolfgang (IFJ PAN); PASECHNIK, Roman (BLTP JINR)

Presenter: BABIARZ, Izabela (Institute of Nuclear Physics Polish Academy of Sciences)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **43** Type: **Talk**

GTMD approach in the production of diffractive dijet in DIS

Friday, 13 September 2024 14:10 (20 minutes)

We calculate differential distributions for diffractive dijets production in $ep \to e'p$ jet jet using off-diagonal unintegrated gluon distributions (GTMDs). Different models are used.
We concentrate on the contribution of exclusive $q\bar{q}$ dijets.
The results of our calculations are compared to H1 and ZEUS data. In general, except for one GTMD, our results are below the HERA data. This is in contrast to recent results where the normalization was adjusted to some selected distributions and no agreement with other observables was checked. We conclude that the calculated cross sections are only a small part of the measured ones which contain probably also processes with pomeron remnant.
We present also azimuthal correlations between the sum and the difference of dijet transverse momenta. The cuts on transverse momenta of jets generate azimuthal correlations which can be misinterpreted.

Primary author: LINEK, Barbara (University of Rzeszow)

Co-authors: Prof. SZCZUREK, Antoni (Insytut Fizyki Jądrowej im. Henryka Niewodniczańskiego Polskiej Akademii Nauk); ŁUSZCZAK, Marta (Instytut Nauk FIzycznych, Kolegium Nauk Przyrodniczych, Uniwersytet Rzeszowski); SCHÄFER, Wolfgang (Insytut Fizyki Jądrowej im. Henryka Niewodniczańskiego Polskiej Akademii Nauk)

Presenter: LINEK, Barbara (University of Rzeszow)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

Contribution ID: **44** Type: **Talk**

Isolated gauge boson production in pp collisions at forward rapidities

Friday, 13 September 2024 14:30 (20 minutes)

The particle production at forward rapidities in hadronic collisions is one of the most promising processes to probe the QCD dynamics at small - x as well as to observe the breakdown of the collinear and k_T factorization theorems, predicted to occur to high partonic densities. In this process, one has the interaction between projectile partons with large cone momentum fractions and target partons carrying a very small momentum fraction. Thus, the projectile parton scatter off a dense gluonic system in the target. In this contribution, we investigate the case where one of the particles in the final state is an electroweak gauge boson ($G = W^{\pm}, Z^0, \gamma$) and present the differential cross-section for the isolated gauge boson production in pp collisions at forward rapidities as a function of the dipole - proton cross-section or the unintegrated gluon distribution, which can be used to estimate the impact of the saturation effects in the gauge boson production at the LHC and future colliders. Moreover, we demonstrate that our general parton-level cross-section reduces to expressions previously used in the literature for the description of the real photon production and Drell - Yan process at forward rapidities in some particular limits.

Primary author: BUENO BANDEIRA, Yan (Federal University of Pelotas / IFJ PAN)

Co-authors: Dr GONÇALVES, Vcitor (Federal University of Pelotas); SCHÄFER, Wolfgang (IFJ PAN)

Presenter: BUENO BANDEIRA, Yan (Federal University of Pelotas / IFJ PAN)

Session Classification: ECR

Track Classification: Particle Physics [Early Career]

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

EIC and the Odderon: exclusive productions of chi_c charmonia

Exclusive chi_c mesons production in DIS is sensitive to the C-odd colorless exchange at high energy, the Odderon. In our recent work we performed a computation of the chi_cJ (J = 0, 1, 2) exclusive production that takes into account the interference with the photon exchange, which is an irreducible background. We give a prediction of number of events one can expect at the EIC. In the low-t region a contribution from the spin dependent Odderon is closely related to the gluon Sivers function, we provide an estimate of this contribution as well.

Primary author: STEBEL, Tomasz (Jagiellonian University)

Co-authors: DUMITRU, Adrian; BENIĆ, Sanjin; MOTYKA, Leszek

Presenter: STEBEL, Tomasz (Jagiellonian University)

Track Classification: Particle Physics [Early Career]

Contribution ID: **46** Type: **Talk**

Small-x evolution and the proton spin puzzle

In recent years, the study of transverse momentum dependent parton distribution function (TMD) received considerable attention in the literature. The understanding of those distributions may help to the resolution of the proton spin puzzle which is one of the main goals of hadron physics. In this presentation I will highlight the use of the small-x formalism in the context of this puzzle and show recent developments with corresponding evolution equations of those TMD. At double logarithmic accuracy, the sub-eikonal evolution for the helicity TMD shows some non-trivial mixing between polarized and unpolarized operators. Those mixing allows the recovery of DLA polarized DGLAP evolution from the small-x formalism at the sub-eikonal level. Those steps (in the polarized sector) fit in an ongoing effort to extend said formalism to interface with the full polarized DGLAP evolution at single logarithmic accuracy.

Primary author: COUGOULIC, Florian (Jagiellonian University)

Presenter: COUGOULIC, Florian (Jagiellonian University)

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

Confronting neutrino mixing schemes with correlations of neutrino oscillation data

Thursday, 12 September 2024 14:00 (20 minutes)

The observed pattern of fermion masses and mixing is an outstanding puzzle in particle physics, generally known as the flavor problem. To explain the typical mixing pattern in the neutrino sector, various mixing schemes are proposed, such as trimaximal mixing (TM1 and TM2), $\mu - \tau$ reflection symmetries, etc. Such mixing schemes can emerge within the framework of discrete flavor symmetries, proving a theoretical origin for observed neutrino mixing and generating specific predictions for the neutrino mixing parameters. Once we consider the correlation among observed neutrino oscillation data, these predictions get further constrained. The methodology proposed here can be implemented in any viable neutrino mixing scheme. In this work, as an example, we discuss constraints on trimaximal (TM1 and TM2) mixing schemes, taking into account the full range of correlations coming from global analysis of neutrino mixing angles and the Dirac CP phase. Furthermore, we also show the implications of such constraints on the effective neutrino masses in the tritium and neutrinoless double beta decay experiments.

Primary author: Mr ZIEBA, Szymon

Presenter: Mr ZIEBA, Szymon

Session Classification: ECR

Contribution ID: **48** Type: **Talk**

Yizhuang Liu - The time-ordering issue of TMD soft factors

Wednesday, 11 September 2024 13:30 (30 minutes)

In this talk I revisit the time-ordering issue of TMD soft factors based on coordinate-space analyticity properties of Wightman functions in Wightman-Osterwalder-Schrader QFTs.

In particular, I show that the TMD soft factor for the DY process in three rapidity regularization schemes can be smoothly connected to each other in a way that maintains certain crucial equalities required for lattice applications.

Presenter: LIU, Yizhuang

Session Classification: Talks

Contribution ID: **49** Type: **Talk**

Martin Rohrmoser - Comparison of in-medium interaction and gluon saturation effects on jet-production

Wednesday, 11 September 2024 14:00 (30 minutes)

Presenter: ROHRMOSER, Martin (UJK-Kielce)

Session Classification: Talks

Contribution ID: **50** Type: **Talk**

Sebastian Sapeta - Particle and Nuclear Theory Activities at the IFJ

Wednesday, 11 September 2024 15:30 (30 minutes)

Presenter: SAPETA, Sebastian

Session Classification: Talks

Contribution ID: **51** Type: **Talk**

Tomasz Stebel - EIC and the Odderon: exclusive productions of chi_c charmonia

Wednesday, 11 September 2024 14:30 (30 minutes)

Presenter: STEBEL, Tomasz (Jagiellonian University)

Session Classification: Talks

Contribution ID: **52** Type: **Talk**

Wojciech Broniowski - Gravitational form factors of the pion: lattice QCD meets the meson dominance

Thursday, 12 September 2024 09:30 (30 minutes)

Presenter: BRONIOWSKI, Wojciech (IFJ PAN/UJK)

Session Classification: Talks

Contribution ID: **53** Type: **Talk**

Adrita Chakraborty - Butterflies revisited for asymptotically Lifshitz black hole

Thursday, 12 September 2024 09:00 (30 minutes)

Session Classification: Talks

Contribution ID: **54** Type: **Talk**

Tomasz Romańczukiewicz - Oscillons in gapless scalar field theories

Wednesday, 11 September 2024 16:00 (30 minutes)

Presenter: ROMAŃCZUKIEWICZ, Tomasz

Session Classification: Talks

Contribution ID: **55** Type: **Talk**

Andrzej Siodmok - QCD ex-Machina: Development of a Deep Generative Hadronization Model

Thursday, 12 September 2024 10:30 (30 minutes)

Presenter: SIODMOK, Andrzej (Jagiellonian Univ. Krakow and LPNHE Paris)

Session Classification: Talks

Contribution ID: **56** Type: **Talk**

Krzysztof Rolbiecki - LHC searches beyond simplified models

Thursday, 12 September 2024 11:00 (30 minutes)

Session Classification: Talks

Contribution ID: **57** Type: **Talk**

Krzysztof Graczyk - Deep learning in modeling lepton-nucleus scattering

Thursday, 12 September 2024 15:30 (30 minutes)

Presenter: GRACZYK, Krzysztof (Institute of Theoretical Physics, University of Wrocław)

Session Classification: Talks

Contribution ID: **58** Type: **Talk**

Florian Cougoulic - Small-x evolution and the proton spin puzzle

Thursday, 12 September 2024 16:00 (30 minutes)

Presenter: COUGOULIC, Florian (Jagiellonian University)

Session Classification: Talks

Contribution ID: **59** Type: **Talk**

Anna Koteja (NCN) - Status and outlook of NCN in 2024 and beyond

Friday, 13 September 2024 09:00 (1 hour)

Session Classification: Talks

Contribution ID: **60** Type: **Talk**

Romuald Janik - Strongly coupled dynamics with a phase transition –some surprises

Friday, 13 September 2024 10:30 (30 minutes)

Presenter: JANIK, Romuald (Jagiellonian University)

Session Classification: Talks

Contribution ID: **61** Type: **Talk**

Michal Spalinski - Attractors in Quark-Gluon Plasma Dynamics

Friday, 13 September 2024 11:00 (30 minutes)

Presenter: SPALINSKI, Michal

Session Classification: Talks

Contribution ID: **62** Type: **Talk**

Alina Czajka - Twist-2 and 3 gluon TMDs from back-to-back DIS dijets

Friday, 13 September 2024 15:30 (30 minutes)

Session Classification: Talks

Contribution ID: **63** Type: **Talk**

David Alverez - QCD phase diagram with multi-messenger observations of compact stars

Friday, 13 September 2024 16:00 (30 minutes)

Presenter: ÁLVAREZ CASTILLO, David (Institute of Nuclear Physics PAS)

Session Classification: Talks