Variants of self-interacting dark matter

Xiaoyong Chu

HEPHY, Vienna

Cosmological simulations suggest that there exists an unexpected mass deficit in dark matter inner halos. This has inspired the study of self-scattering dark matter models, especially velocity-dependent self-interactions. I will talk about two new mechanisms to achieve the desired velocity-dependence: to introduce resonant self-scattering among dark matter particles, or to assume that the ``charge radius'' of a composite dark matter particle is much larger than its Compton wavelength. Both work well as alternatives to light mediator models, which were widely believed to be the only way to achieve that effect.

Overview of the current efforts at the panEDM experiment

Hanno Filter

TU - München

The value of the neutron's electric dipole moment (EDM) d_n is deeply connected with fundamental questions in contemporary physics [1]. The observed baryon/anti-baryon asymmetry of the universe can be explained by the existence of new CP-violating processes, which would give rise to additional contributions to d_n in most models [2]. Known CP-violating processes in the Standard Model lead to a prediction for d_n of order 10^{-32} e·cm [3], but are insufficient to explain the matter/antimatter asymmetry. The current best experimental limit on $|d_n|<3\times10^{-26}$ e·cm (90% C.L.) [4, 5] is still several orders of magnitude larger than the SM prediction. Improving the experimental sensitivity further is thus a unique opportunity to search for new physics beyond the Standard Model.

Neutron EDM searches typically compare spin precession of trapped ultra-cold neutrons (UCN) with a stable clock in an applied high electric field. One approach to limit systematic uncertainties in this type of experiment is to utilize two storage chambers, allowing for simultaneous differential measurements with two electric field directions. In PanEDM this approach is supported by exceptional low-frequency magnetic shielding, advanced optical magnetometry systems, and a high-density superthermal UCN source (SuperSUN) [6].

The experiment is currently under commissioning at the Institut Laue-Langevin, and characterizations of individual systems will continue until UCN production is started at SuperSUN.

[1] Chupp et al., 2018

[2] Pospelov & Ritz, 2005

[3] Seng, 2015

[4] Pendlebury et al., 2015

[5] Baker et al., 2006

[6] Wurm et al., 2019 (tbp)

Dual representation for lattice gauge theory

Joshua Hoffer

University of Graz

The key idea of the project is to rewrite SU(2) lattice field theory in terms of dual variables which correspond to discretised surfaces on the lattice. It is expected that this new representation better reveals geometric and topological aspects of the theory and furthermore could help to implement finite density lattice field theory without complex action problem. The contribution summarizes the approach and the current status of the project.

Looking for the unexpected in the ordinary at the LHC

Ilse Krätschmer

HEPHY, Vienna

We have no idea what 95% of our universe is made of. Moreover, we still do not understand how the 5% of visible ordinary matter that we know about are bound by the strong force. Studying heavy quark-antiquark states called quarkonia helps completing our knowledge about hadron formation.

Quarkonium states are easily accessible at the LHC through their dimuon decay. The so-called S-wave quarkonia are well studied by now, contrary to their counterparts with higher angular momentum. But do the simple patterns found for S-wave states also extend to higher angular momentum states? Is quarkonium production independent of mass and quantum numbers?

This talk introduces basic concepts of quarkonium production, discusses measurements at the LHC and presents prospects of the first measurement of P-wave polarizations at the CMS experiment.

Vacuum Energy Constraints on Extra Higgs Bosons

Janina Krzysiak

IFJ PAN in Krakow

Many new physics searches at the LHC focus on extra Higgs bosons; such bosons are predicted by a variety of 2HDMs (Two Higgs Doublet Models), including the type-II 2HDM, which corresponds to the Higgs sector of SUSY, and other BSM models. So far, no extra Higgs bosons have been found, but limits set by direct searches, results from precision measurements of B decays, and global electroweak fits have constrained the 2HDM phase space considerably. Possible additional constraints on extra Higgs bosons come from solutions to two “naturalness puzzles” in fundamental physics: the small value of the SM Higgs boson mass compared to the Planck scale, and the small observed value of the cosmological constant compared to the large value obtained by evaluating zero-point energies to the Planck scale. The Pauli conjecture, which states that summing over fermions and bosons might cancel the zero-point energy, and the Veltman condition for cancelling quadratic divergences in the Higgs mass self-energy can both be used as constraints on BSM particles.

Exploring new physics at lifetime frontier

Suchita Kulkarni

HEPHY, Vienna

In the search for new physics beyond the Standard Model, the searches for long lived particles play an important role. They not only arise in several beyond the Standard Model scenarios, but also leave interesting signatures at the cosmic and detector scales. I will take an overview on how different probes ranging from laboratory experiments to early Universe, probe the lifetime frontier of new physics scenarios. In particular, I will demonstrate avenues to systematically use existing results for long lived particles and potential of proposed experiments.

Stellar emission of light dark states

Jui-Lin Kuo

HEPHY, Vienna

It is possible that dark sector particles are perfectly neutral but still coupled to photons through higher order electromagnetic form factor. Based on the effective theory and focusing on the sub-GeV mass range, we scrutinise the production of the light dark states in various stellar objects. Relevant processes such as electron-positron annihilation, plasmon decay and bremsstrahlung are investigated, with thermal effects included. Additional energy loss conducted by the light dark states alters the typical lifetime of stars, thus giving us a leverage to set constraints on effective couplings.

The effective potential method in 5D warped models

Javier Lizana

University of Warsaw

Warped extra dimensions have been widely used in the last twenty years to address the hierarchy problem and construct phenomenologically viable BSM models. These models require some mechanism to stabilize the size of the extra dimension, which usually produce a light radion. A common tool used to study the stabilization mechanism is the effective potential of the radion and several approximations to it. This object takes a crucial role in finite temperature calculations, relevant to study possible phase transitions that these models predict in the early universe. In this talk I will discuss different approximations used to compute the effective potential. I will analyze their exact meaning, what trustable information we can extract from them, and under which circumstances they are a good approximation to the exact solution.

Nuclear ground-state properties in the context of V_{ud} and the 4-sigma tension in the CKM unitarity test

Stephan Malbrunot-Ettenauer

CERN

Domain decomposition techniques in finite density lattice QCD

Michael Mandl

University of Graz

We consider finite-density QCD on the lattice and employ domain decomposition techniques combined with multi-boson integration. After partitioning the lattice into thick time slices, called domains, the fermion determinant factorizes into contributions independent of the chemical potential μ and a determinant of a boundary operator that does depend on μ. We investigate the spectra of the latter to explore their use for expansion- or density-of-states - methods.

Charm baryon production in pp, p–Pb and Pb–Pb collisions with ALICE at the LHC

Elisa Mennino

SMI, Vienna

Charm quarks are an effective probe used for the investigation of the Quark-Gluon Plasma (QGP) created in high-energy heavy-ion collisions. They are produced in hard scattering processes on a timescale shorter than the QGP formation time and experience the whole system evolution.

There have been extensive researches regarding the production of charm mesons in heavy-ion collisions to investigate the interactions of charm quarks with the QGP constituents and the transport properties of the medium. The measurement of charmbaryon production, and in particular the baryon-to-meson ratios, provides unique information on hadronisation mechanisms, constraining the role of coalescence and testing the predicted presence of diquark states in the QGP.

Measurements of charm-baryon production in pp and pPb collisions are also essential to establish a baseline for PbPb collisions. In addition, the measurements in pp collisions provide critical tests of pQCD calculations and models of charm hadronisation in vacuum while the measurements in pPb collisions are useful to study cold nuclear matter effects and the possible evolution with charged-particle multiplicity of the modification of charm hadronisation.

In this talk, ALICE results of charm-baryon measurements in pp, p-Pb, and Pb-Pb collisions are presented. The comparison with model calculations will be discussed.

ATLAS beam condition monitor simulation for high luminosity run

Jakob Novak

University of Ljubljana

Beam condition monitor (BCM) is a part of ATLAS detector, being used for luminosity measurements and emergency abort in the case of bad beam behaviour. It is the only part of ATLAS detector that can efficiently discriminate between collisions and non-collision background at all stages of datataking, based on precise time measurement. It is installed just outside of the beam pipe, 1.9 m from the interaction point. For high luminosity LHC run, current BCM system will be upgraded to BCM-prime. In order to carry out the performance studies for BCM-prime, it is very important to integrate it in the ATLAS upgrade simulation and adapt current geometry and digitisation code.

Effective Field Theories in R_ξ gauges

Michail Paraskevas

University of Warsaw

In effective quantum field theories, higher dimensional operators can affect the canonical normalization of kinetic terms at tree level. These contributions for scalars and gauge bosons should be carefully included in the gauge fixing procedure, in order to end up with a convenient set of Feynman rules. In this talk I will present such a setup for the linear R_ξ-gauges. It involves a suitable reduction of the operator basis, a generalized gauge fixing term, and a corresponding ghost sector. The approach extends previous results for the dimension-six Standard Model Effective Field Theory to a generic class of effective theories with operators of arbitrary dimension.

Two-loop corrections to electron-muon scattering at NNLO in QED

Amadeo Primo

Universität Zürich

We present the evaluation of the two-loop virtual corrections to the electron-muon scattering at Next-to-Next-to-Leading order (NNLO) in QED. These radiative corrections are relevant for the analysis of the MUonE experiment, recently proposed at CERN. MUonE aims at the high precision determination of the QED running coupling constant in the space-like region from the measurement of the differential cross section of the elastic scattering of high-energy muons on atomic electrons. The precise theoretical knowledge of QED corrections will allow to extract from the experimental data the hadronic contribution to the running coupling constant. This will provide a new and independent determination of the leading-order hadronic correction to the muon g−2.

Supersymmetric Airy structures

Blazej Ruba
Jagiellonian University in Krakow
Based on joint work with V. Bouchard, P. Ciosmak, L. Hadasz, K. Osuga, P. Sulkowski.

Airy structures are algebras of differential operators engineered to solve topological recursion relations. Equations of this form were encountered in several problems in random matrix theory, conformal field theory and enumerative geometry. From a slightly different perspective, construction of Airy structures is an interesting example of deformation quantization program. This point of view is a natural starting point for supersymmetric generalizations. I will present the definition, several examples and basic properties of super Airy structures.

Few nucleon calculations without angular momentum decomposition

Kacper Toplonicki

Jagiellonian University in Krakow

An overview of the, so called, "three dimensional" approach to performing calculations related to few (two, three) nucleon systems will be presented. This new approach does not rely on the partial wave decomposition of operators relevant to the calculation. Instead it works directly with the "three dimensional" momentum degrees of freedom of the nucleons. Skipping the partial wave decomposition procedure and performing calculations with, what is effectively all partial waves at once (in practice this is of course limited by numerical precision and the amount of computing resources available) has the potential to make testing new models of nuclear interactions more efficient and performing calculations related to systems with higher energies and shorter ranged interactions easier. Additionally, some recent "three dimensional" results related to 3He with a screened Coulomb interaction will be shown.

Search for polarization in the antiproton production process

Marcin Zielinski

Jagiellonian University in Krakow