2024 Talks and abstracts - alphabet order (authors)

Tomáš Blažek

Search for Signals of Dark New Physics

It is generally believed that in the particle world, the Standard Model cannot be accepted as the ultimate theory. In this talk we review searches for Beyond Standard Model Physics that attempt to reveal presence of dark particles. A significant part of the talk will summarize results of the NA62 Experiment presented at recent high-energy physics conferences.

Eugenia Boffo

(Quantum) field theory from another angle

Field theories in physics are formulated from an action functional that encodes the dynamics and the conservation laws. Quantization is based on an arguably ill-defined object, the path integral; through the celebrated Feynman diagrams it is possible to perturbatively know the quantum corrections to a classical n-points scattering process.

Such a description has proven to be very effective. However it could be rather hostile for mathematicians.

A complementary point of view, which originated from the necessity to deal with field theories that possess gauge invariances, is, in my opinion, equally deserving of attention. Its nature is essentially homological and homotopical (that is to say that analytical issues will be discarded in this talk). The proper buzzwords for this method are: BRST-BV, homotopy algebras, homotopy retract and homological perturbation lemma. These concur to provide an appealing framework for quantum field theory, and will be gently discussed in this talk.

Sebastian Brezina

On the geometrical approach to gravity

We start with a general discussion of Metric-affine geometries and then restrict to the two specific cases used in gravity: pseudo-Riemannian and teleparallel geometries. To understand why these two geometries are suitable for describing gravitational effects, we need to first demonstrate in detail how the Strong Equivalence Principle

leads to the description of gravitational phenomena as a manifestation of spacetime curvature and to the use of the Levi-Civita connection in General Relativity.

Marián Fecko

Hodge star operator: From Galilei to Galilean

It turns out that the standard (pseudo)Riemannian Hodge star is, modulo some freedom, the only intertwining operator for (appropriate) representations on forms. This is a good start to define the Hodge star also in Galilean (rather than Lorentzian) space-time (where the standard approach fails). The important step from (simple) Galilei space-time to (much more general) Galilean case may be based on the simple and general concept of "geometric quantity of type rho".

Ladislav Hlavatý

Supergravity Equations and Jacobi_Lie T-plurality

Extension of Drinfel'd doubles to Leibniz algebras provides basis for Jacobi-Lie T-plurality that similarly to Poisson Lie T-pluraity can serve for finding solutions of Supergravity equations. Examples in the form of plane-parallel waves will be given.

Goce Chadzitaskos

On the Schwinger's speculative hypothesis

In 1969, Julian Schwinger published the paper "A magnetic model of matter" in which he used an analogy of magnetic forces to electric ones. He tried to quantize the magnetic charges and explained the strong interactions in terms of magnetic attractions. It had brought an unconventional view on the nature of matter and particles. Nucleons are composed of particles with both magnetic and electric charges.

Juraj Kováč

The basics of matching theory

(Seemingly) non-trivial proofs of (seemingly) trivial statements Hall's proof (1935) of the so-called marriage theorem laid the fundaments of what is usually referred to as matching theory, a framework with a wide variety of applications ranging from economics to fundamental mathematics (e.g. number theory). We present the basics

of this framework and sketch the proofs of some intuitive, yet non-trivial results, demonstrating a selection of interesting phenomena along the way.

Marián Lukáč

Generalized Geometry and Algebroids

In this presentation, we shall introduce the concept of Leibniz, Lie and Courant algebroids. These mathematical structures generalize the notion of the corresponding algebras. They appear in the geometrical formulation of supergravity theories. We will begin with the definitions of our machinery along with a few illuminating examples followed by some basic properties and applications in physical theories. We conclude by mentioning future perspectives and some open questions in this field.

Peter Mészáros

Classification of perturbations in a flat universe with anisotropic expansion

Perturbations in a flat and isotropic universe with Friedmann-Lemaître-Robertson-Walker metric as the background can be classified into scalar, vector, and tensor parts. This is based on Euclidean symmetry of the space part of the metric. If we generalize this setup to the case with anisotropic expansion with anisotropy in one of three spatial directions, which represents a special case of Biachi Type-I metric, the usual classification of perturbations changes. The talk will be focused on classification of perturbations in the anisotropic case and comparison with the usual isotropic case by taking the limit of small anisotropy.

Filip Moučka

Generalized geometry with skew-symmetric pairing

Generalized geometry is the study of the geometry of T+T* with the canonical symmetric pairing and the Dorfman bracket. If instead of the symmetric pairing one considers the skew-symmetric pairing, the Dorfman bracket is no longer suitable. We introduce a new bracket and discuss some basic features of generalized geometry with the skew-symmetric pairing.

Petr Novotný

tba

Ľuboš Ravas

From Hamiltonian mechanics to BRST cohomology

In classical physics, mechanical systems can be described by Hamiltonian functions and Poisson brackets. Furthermore there often appears a Lie group acting on the systems, which gives rise to symmetries, which can put constraints on the mechanic. It is problematic to deal with smooth functions of the symplectic quotient, therefore it is common to resort to BRST. The latter is a set of techniques which turns the problem into the computation of a cohomology. In this presentation we will explain these concepts and discuss BRST cohomology for a system with SO(3) symmetry and reducible constraints.

Stanislav Skoupý:

State transfer based on quantum walks between multiple hubs

We introduce algorithms for search and state transfer that utilize discrete-time quantum walks with coins. These algorithms are implemented on hubs within a graph, defined as vertices that have connections to all other vertices. We show that the search algorithm finds multiple marked hubs with a probability close to one. We use the state transfer algorithm to send a walker between multiple senders and multiple receivers. We illustrate that fidelity of the state transfer depends on the number of senders and receivers, and also on the initial state located on sender vertices.

Daniel Štěrba:

Consensus in Quantum Networks

The talk concerns consensus formation in qubit networks with random unitary interactions. It introduces a scheme for asymptotic distribution of a particular global information of the network among its individual nodes, so that it becomes readable locally and equally at each site. If time allows, an example will be shown of a possible realization of such a network using a quantum computer.

Vojtěch Teska:

Discrete transforms on lattices in the root systems of type A_n

The theory of Lie algebras revolves around root systems, which give rise to four classical lattices invariant under the action of the associated Weyl group. We define discrete Fourier-type transforms on shifted invariant lattices using orbit functions.

This talk will focus on the root systems of type A_n, where it is possible to find additional invariant lattices, with examples from A_3. The general theory of discrete orbit function transforms, which unites the previously known results along with providing new ones, is the focus of our current research.

Fridrich Valach

Introduction to BRST and BV via graded geometry

Using the language of finite-dimensional graded geometry I will provide a gentle introduction to the BRST and BV framework. I will then present a simple toy model for the N=1 D=10 supergravity which (in some sense) replaces the physical spacetime by a Lie algebra. Still, this approach captures some symmetries of the original supergravity theory, allows a nice BV formulation, and leads to some interesting (and potentially new) insights. This is based on a joint work with Julian Kupka and Charles Strickland-Constable.

Vojtěch Vanc:

Spinors in classical field theory

We will explore a link between classical fluids and spinor field theories. We will introduce a new formalism where spinors are represented by 2 by 2 complex matrices. In this new picture, the fluid is described by additional 4 parameters which can be connected to the intrinsic angular momentum. Possible applications in plasma physics will be discussed.

Šimon Vedl

Pomlazka as a quantum computer

In the race to construct the first quantum computer, several schemes have been put forward to show how to represent and process quantum information. Topological quantum computation is a scheme where the information is stored and processed in a robust way relying only on topological properties. This talk is meant to be an introduction to this topic which combines interesting mathematics and even more interesting physical systems.

Thomas Weber

Hopf algebras in mathematical physics

We give a gentle introduction to the concept of Hopf algebra and discuss two of its applications. Also known by the name “quantum groups” Hopf algebras pose as group analogs in the world of noncommutative differential geometry. On the other hand, they appear in renormalization of quantum field theory as the combinatorial essence of the “forest formula”. After defining Hopf algebras and discussing some fundamental examples we explore the two previous frameworks in order to understand the power and flexibility of Hopf algebra theory.