Recent Development in Theoretical Physics and its Neighbourhoods

O' Zappatore Nun S' 'A Scord' 'A Mamma

5th edition

Studenti ed (ex)studenti del gruppo di Metodi Matematici per la Fisica illustreranno i loro recenti lavori

Dipartimento di Fisica "E. Pancini"
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Aula 2G26

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TIMETABLE

9:45 – 10:00	Greetings
10:00 – 10:40	Learning t-doped Gaussian states (Salvatore Oliviero)
10:40 – 11:20	Complexity of quantum spacetime (Simone Cepollaro)
11:20 – 11:40	Break
11:40 – 12:20	Relational subsystems and gauge-invariant entanglement entropy (Fabio M. Mele)
12:20 – 13:00	A tentative to understand Jordan and Einstein frames from the Hamiltonian analysis (Gabriele Gionti)
13:00 – 14:20	Lunch break
14:20 – 15:00	A representation theory for waves localized in space-time (Marco Laudato & Elias Zea)
15:00 – 15:40	The inverse problem for gauge theories via coisotropic embeddings (Luca Schiavone)
15:40 – 16:20	Jacobi sigma models and twisted Jacobi structures (Francesco Bascone)
16:20 – 16:40	Break
16:40 – 17:20	Convex orderings on quantum root vectors and differential calculi (Alessandro Carotenuto)
17:20 – 18:00	Some remarks on Čencov theorem (Fabio Di Cosmo)
18:00 –18:40	Possono le mappe (della rete) essere utili per fare sicurezza informatica? (Antonio Russo)

ABSTRACTS

Learning t-doped Gaussian states

Salvatore Oliviero
University of Massachusetts Boston

Learning quantum states without prior knowledge of their structure can be exponentially challenging, as observed in the case of state tomography. There are, however, notable exceptions for discrete dimensions where the structure of the unknown state can be efficiently encoded, such as with stabilizer states and quantum phase states with fixed degrees. In our study, we extend this concept to t-doped Gaussian states, which arise from vacuum states through applying Gaussian unitaries augmented with a finite number of non-Gaussian unitaries. We demonstrate that these states can be efficiently learned up to t order $\log(n)$. To tackle this complex problem, we first establish the specific structural properties inherent to such states and devise a probabilistic learning protocol. Remarkably, our algorithm exhibits a resource complexity of $\mathcal{O}(\exp(t)\text{poly}(n))$ and offers an exponentially low probability of failure.

Complexity of quantum spacetime

Simone Cepollaro
Scuola Superiore Meridionale & INFN Napoli

In the last decade, quantum information theory has become a central ingredient in understanding the structure of *quantum spacetime*. For example, in many non-perturbative and background-independent theories, Entanglement is considered to be the fundamental tool to investigate the emergence of classical specetime from network of correlations. In this talk, we will discuss the second layer of quantumness of a quantum gravity theory, that is *complexity*. We briefly introduce Stabilizer Rényi Entropy as a measure of complexity and show some preliminary results on the complexity of the fundamental building blocks of a simplicial description of quantum space.

Relational subsystems and gauge-invariant entanglement entropy

Fabio M. Mele
University of Western Ontario

One of the most basic notions in physics is the partitioning of a system into subsystems, and the study of correlations among its parts. Operationally, subsystems are distinguished by physically accessible observables which are often implicitly specified relative to some external frame such as the laboratory. In absence of external relata as in Page-Wootters dynamics, gauge theories, and gravity, physical observables must be relationally specified relative to some internal dynamical degrees of freedom. In this talk, I will discuss how different internal frames identify distinct external-frame-independent/gauge-invariant notions of subsystems, first for simple finite-dimensional systems and then move to local subregions in gauge theories for which the

dynamical frames are provided by boundary edge modes. As a consequence, physical properties of subsystems are contingent on the choice of internal frame. Special attention will be reserved to subsystem entropies and I will explain how such a relational definition of subsystems provides an alternative proposal for defining entanglement entropy in gauge theories.

A tentative to understand Jordan and Einstein frames from the Hamiltonian analysis

Gabriele Gionti
Specola Vaticana (Vatican Observatory) & LNF-INFN (Frascati)

We will briefly summarize some recent results obtained in the Hamiltonian formalism for the Brans-Dicke theory. We will show that these results can be used to address equivalence (if any...) between Jordan and Einstein Frames. Although we will show that there is a mathematical equivalence between these two frames, a pair of examples points out that the two frames do not look to be physically equivalent.

A representation theory for waves localized in space-time

Marco Laudato & Elias Zea
KTH Stockholm

A continuous transform for transient waves in 2D space-time is presented. The construction is experimentally supported with a sparse coding of natural acoustic waves, and it preserves the dispersion relation of the propagation medium by using the Poincaré group with isotropic dilations. Two-dimensional boostlets, $\psi_{a,\theta,\ell}(x,t) \in L^2(\mathbb{R}^2)$, are spatiotemporal functions parametrized with dilations $a > 0$, Lorentz boosts $\theta \in \mathbb{R}$, and translations $\ell \in \mathbb{R}^2$. It is shown that the continuous boostlet transform is an isometry for $L^2(\mathbb{R}^2)$. The Heisenberg uncertainty principles associated with the boostlet transform and their corresponding minimizers are discussed.

The inverse problem for gauge theories via coisotropic embeddings

Luca Schiavone
University Carlos III Madrid

We present the coisotropic embedding theorem as a tool to provide a solution of the inverse problem of the calculus of variations for physical systems whose dynamics is represented by a vector field over a pre-symplectic manifold.

Jacobi sigma models and twisted Jacobi structures

Francesco Bascone
INFN Napoli

Jacobi sigma models are two-dimensional topological non-linear gauge field theories which are associated with Jacobi structures. The latter can be considered as a generalization of Poisson

structures. After reviewing the main novelties and peculiarities of these models, I will focus on the twisted version in which a Wess-Zumino term is included. This modification allows for the target space to be a twisted Jacobi manifold, and in particular I will discuss the model on the sphere $\mathbb{S}^5$ as an example of a twisted contact manifold.

Convex orderings on quantum root vectors and differential calculi

Alessandro Carotenuto
Charles University

Complex differential geometry of quantum homogeneous spaces is a field in rapid ascension, unveiling new links between noncommutative differential geometry and representation theory of quantum groups. In this talk I will discuss the recent findings of Ó Buachalla and Somberg that certain PBW bases for the quantum enveloping algebras allow for the construction of differential calculi for the associated quantum flag manifolds. After reviewing the notion of convex ordering on the set of positive roots of a Lie algebra, I will present a conjecture (that might become a theorem by the time I will actually give this talk) that allows to state the existence of differential calculi for quantum flag manifolds in terms of convex orderings or, equivalently, just by looking at the chosen PBW basis.

Some remarks on Čencov theorem

Fabio Di Cosmo
ICMAT & University Carlos III Madrid

In this talk I will review the categorical approach to statistical decision theory introduced by Čencov. The aim of the talk consists in showing that Čencov celebrated theorem characterizing Fisher-Rao metric tensor in Information Geometry can be actually extended using an algebraic approach to the set of tracial states of a finite dimensional von Neumann algebra. These remarks allow to shed more light also on some algebraic aspects of Petz theorem.

Possono le mappe (della rete) essere utili per fare sicurezza informatica?

Antonio Russo
ARS Informatica s.a.s.

Il Risiko si gioca su una mappa. È possibile giocare a Risiko senza mappe? Si ma è molto più difficile. Le mappe giocano un ruolo cruciale nella vita di tutti i giorni, lo possono giocare in uno scenario di CyberWar? Dopo una breve introduzione alla sicurezza informatica ed alle mappe di rete si vuole discutere quanto le mappe possono semplificare le azioni necessarie per difendere lo spazio informativo.