

Preventivo - BELL 2021

Consiglio di Sezione - Genova

16th July 2020

Involved Sections:

COSENZA, GENOVA, MILANO, PAVIA, TRENTO, TRIESTE

General topics of the BELL network:

- quantum aspects of gravity
- foundations of quantum mechanics
- foundations of classical and quantum statistical mechanics
- quantum information
- mathematical methods of quantum mechanics and quantum field theory

- Nicola Pinamonti (PO)
- Nino Zanghì (PO)
- Pierre Martinetti (Rtdb)
- Paolo Solinas (Rtdb)
- Marco Benini (Rtda)
- Paolo Meda (PhD student)
- Piero Truini (senior)

■ QUANTUM GRAVITY MODELS

Gravity quantum physics interplay will be analyzed in two different ways.

- 1 Using semiclassical Einstein equation (properties of their solutions)
- 2 Using Hamilton-Jacobi formulation to analyze the dynamics of the geometry.

We aim to obtain some models which describe our universe at early stage after Big Bang and some models of black hole evaporation.

■ MATHEMATICAL ASPECTS OF QUANTUM FIELD THEORY

We shall study some aspects of interacting quantum field theories on flat and curved spacetime.

- 1 Perturbative construction of states at finite temperature in the adiabatic limits.
- 2 Foundational aspects in the quantization of gauge fields. A deeper understanding of the structure of gauge theories has recently been proposed following a geometric interpretation of the well-established BRS - BV approach using higher and derived geometry.

■ NONCOMMUTATIVE GEOMETRY AND THE STANDARD MODEL

Regarding the application of noncommutative geometry to high energy physics

- 1 We study how how to implement Lorentz invariance within Connes theory of spectral triple.
- 2 We want to show that the transition from the euclidean to the lorentzian also occurs for the fermionic action of the Standard Model.
- 3 Develop models beyond the Standard Model and we aim to study the phenomenology of this model.

■ STATISTICAL MECHANICS AND QUANTUM MECHANICS

We will study the energy exchanges in driven quantum systems.

- 1 Theoretical and operational definition of the work done and dissipated heat in quantum systems.
- 2 We plan to propose an operational and consistent definition of quantum heat that is still missing in literature.
- 3 We plan to extend to at quantum level the classical concept of power and clarify how its measure can give information about the work and heat at quantum level.
- 4 We plan to study the relation between the statistics of quantum work and heat generated during the quantum dynamics.

Paolo Meda (tutors: N. Zanghi and N. Pinamonti)

- Study the back reaction of a massive quantum scalar field on flat cosmological spacetimes and analysis of the existence of a solution of the semiclassical Einstein equation.
- Study the back reaction of a massive quantum scalar field for spherically symmetric Black Holes.

Manuele Filaci (tutors: C. Biggio and P. Martinetti)

- Study of phenomenological aspects of the effective standard model arising from non commutative geometry.

Collaborations

- R. Verch (University of Leipzig, Germany)
- C. Dappiaggi (University of Pavia)
- H. Gottschalk (University of Wuppertal, Germany)
- K. Rejzner, D. Siemssen, C. Fewster, (University of York, UK)
- K. Fredenhagen (University of Hamburg, Germany)
- D. Bahns (University of Göttingen, Germany)
- A. Schenkel (University of Nottingham, UK)
- J.-C. Wallet (CNRS - Université Paris-Orsay, France)
- F. Besnard (EPF - Paris, France)
- S. Farnsworth (Einstein Institute. Golm, Germany)
- J. Lebowitz, Sheldon Goldstein (Rutgers, USA)
- R. Tumulka (University of Tübingen, Germany)
- D. Dürr (University of Munich, Germany)
- S. Gasparinetti (Chalmers University of Technology, Sweden)
- J. Pekola (Aalto University, Finland)
- J. Anders (University of Exeter, England)

■ Statistical Mechanics and Quantum Mechanics

- **Comparison of Gibbs and Boltzmann entropy. Discussion of the quantum analog of the Boltzmann entropy**
S. Goldstein, J. L. Lebowitz, R. Tumulka, N. Zanghi *Gibbs and Boltzmann Entropy in Classical and Quantum Mechanics* (Springer, 2019)
- **Energy exchanges in driven quantum systems**
P. Solinas, M. Amico *Measure of the work and heat statistics in quantum systems* (in preparation)
- **Quantum version of the relational formulations of classical mechanics and gravity**
D. Dürr, S. Goldstein, N. Zanghi *Quantum Motion on Shape Space and the Gauge Dependent Emergence of Dynamics and Probability in Absolute Space and Time*. J. Stat. Phys. (2019)
- **Interior-boundary conditions and the problem of ultraviolet divergences**
D. Dürr, S. Goldstein, S. Teufel, R. Tumulka, N. Zanghi *Bohmian Trajectories for Hamiltonians with Interior-Boundary Conditions*. J. Stat. Phys. (2019)

■ Quantum Field Theory and Quantum Gravity

- **Effective theories for interacting quantum field theories on quantum spacetime.**
S. Doplicher, G. Morsella, N. Pinamonti *Quantum Spacetime and the Universe at the Big Bang, vanishing interactions and fading degrees of freedom* (2019) [1911.04756]
S. Doplicher, G. Morsella, N. Pinamonti *Perturbative Algebraic Quantum Field Theory on Quantum Spacetime: Adiabatic and Ultraviolet Convergence* Accepted for Publication on CMP (2019) [1906.05855/]
- **Equilibrium states of Thermal Field Theory and KMS states** J. Braga de Góes Vasconcellos, N. Drago, N. Pinamonti *Equilibrium states in Thermal Field Theory and in Algebraic Quantum Field Theory* Ann. Henri Poincaré 21, 1-43 (2020) [1906.04098/]
N. Pinamonti, K. Sanders, R. Verch *Local incompatibility of the microlocal spectrum condition with the KMS property along spacelike directions in quantum field theory on curved spacetime* Lett. Math. Phys. 109, 1735-1745 (2019) [1806.02124/]
R. Brunetti, K. Fredenhagen, N. Pinamonti *Algebraic approach to Bose Einstein Condensation in relativistic Quantum Field Theory. Spontaneous symmetry breaking and the Goldstone Theorem* (2019) [1911.01829/]
- **Exceptional Lie algebras and applications**
P. Truini, M. Rios, A. Marrani, *The Magic Star of Exceptional Periodicity*, Contemporary Mathematics 721, 277-297, Amer Math Soc (2019).
P. Truini, A. Marrani, M. Rios, *Magic Star and Exceptional Periodicity: an approach to Quantum Gravity*, J. Phys. Conf. Ser. 1194 N. 1 (2019).
P. Truini, *Vertex operators for an expanding universe*, AIP Conference Proceedings 2150, 040005 (2019);

■ Noncommutative Geometry and Standard Model

- **Transition from the Euclidean to the Lorentzian signature in noncommutative geometry**
D. Singh, P. Martinetti *Lorentzian fermionic action by twisting riemannian spectral triples* (2019)
- **Metric aspect of noncommutative geometry and optimal transport**
F. D'Andrea, P. Martinetti *A dual formula for the spectral distance in noncommutative geometry* (2019)

■ Quantization of Gauge fields

- **Higher structures in gauge theories**
M. Benini, A. Schenkel, *Higher structures in algebraic quantum field theory*, Fortschritte der Physik (2019). – M. Benini, A. Schenkel, L. Woike, *Homotopy theory of algebraic quantum field theories*, Lett. Math. Phys. (2019)
- **Higher Abelian gauge theory from a differential geometric viewpoint**
C. Becker, M. Benini, A. Schenkel, R. J. Szabo, *Cheeger-Simons differential characters with compact support and Pontryagin duality*, Commun. Anal. Geom. (2019)
- **Formal aspects of algebraic quantum field theories**
M. Benini, A. Schenkel, L. Woike, *Operads for algebraic quantum field theory*, Commun. Contemp. Math. (2020) – M. Benini, M. Perin, A. Schenkel, *Involutive categories, colored $*$ -operads and quantum field theory*, (2019) – M. Benini, M. Perin, A. Schenkel, *Model-independent comparison between factorization algebras and algebraic quantum field theory on Lorentzian manifolds*, (2019)

Financial requests

- 18k euro for missions

Requests of services

- Access to numerical computations facilities
- Licenses of Mathematica