INFN Gr IV
Area: Mathematical Physics

BELL — fundamental problems in quantum physics

GENOVA, PAVIA, MILANO, TRIESTE, COSENZA, TRENTO

National Coordinator: Nino Zanghì

The goal is to meet the challenges of the research in the foundations of quantum mechanics which are of primary interest both theoretically and experimentally, with particular focus on the interplay between gravity and quantum physics

- Quantum aspects of gravity
- Foundations of quantum mechanics
- Foundations of classical and quantum statistical mechanics
- Quantum information
- Mathematical methods of quantum mechanics

Genova

- Nino Zanghì (PO)
- Nicola PInamonti (PO)
- Piero Truini (senior)
- Pierre Martinetti (Rtdb)
- Marco Bernini (Rtda)
- Paolo Meda (PhD student)

Foundations of Statistical Mechanics

- ***Comparison of Gibbs entropy and Boltzmann entropy and discussion of the quantum analog of the Boltzmann entropy based on recent works on thermalization of closed quantum systems.***

  S. Goldstein, J. L. Lebowitz, R. Tumulka, N. Zanghi *Gibbs and Boltzmann Entropy in Classical and Quantum Mechanics* (2019) [1903.11870]

Foundations of Quantum Mechanics

- ***Quantum version of the relational formulations of classical mechanics and gravity that have been developed by Julian Barbour and collaborators.***

  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*. To appear on J. Stat. Phys.

- ***Development of interior-boundary conditions as a technique for avoiding the problem of ultraviolet divergences.*** D. Dürr, S. Goldstein, S. Teufel, R. Tumulka, N. Zanghi *Bohmian Trajectories for Hamiltonians with Interior-Boundary Conditions*. To appear on J. Stat. Phys.

Quantum Field Theory and Quantum Gravity

- ***Construction of an effective theory which describes interacting quantum field theories on quantum spacetime. The quantum nature of spacetime induces an effective non local interaction Lagrangian which was already known in the literature. We have shown how to use this lagrangian to obatain an unitary S-matrix.***

  S. Doplicher, G. Morsella, N. Pinamonti *Perturbative Algebraic Quantum Field Theory on Quantum Spacetime: Adiabatic and Ultraviolet Convergence* (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* (2019) [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. (2019) online first [1806.02124/]

N. Drago, F. Faldino, N. Pinamonti *Relative Entropy and Entropy Production for Equilibrium States in pAQFT* Ann. Henri Poincaré 2018 (2018) 3289-3319 [1710.09747/]

K. Fredenhagen, T.-P. Hack, N. Pinamonti *Thermodynamics of Quantum Fields in Nonstationary Spacetimes* Book Chapter (2018) [1809.08557/]

N. Drago, F. Faldino, N. Pinamonti *On the stability of KMS states in perturbative algebraic quantum field theories* Comm. Math. Phys. 357 (2018) 267-293 [1609.01124/]

Noncommutative Geometry and Standard Model

- ***How to obtain from a noncommutative fermionic action Weyl and Dirac equations***

  D. Singh, P. Martinetti *Lorentzian fermionic action by twisting riemannian spectral triples*

- ***Works on Connes spectral distance in noncommutative geometry***

  F. D'Andrea, P. Martinetti *A dual formula for the spectral distance in noncommutative geometry* (2019 [arXiv:1]807.06935]

  P. Martinetti *Connes distance and optimal transport* [1803.07538]

- ***Spectral triples in noncommutative geometry***

  A. Devastato, F. Lizzi and S. Farnsworth *Lorentz signature and twisted spectral triples* JHEP 03 (2018) 89

  G. Landi, P. Martinetti *Gauge transformations for twisted spectral triples* Lett. Math. Phys. 108 (2018) 12

PhD work

Paolo Meda (I year PhD), tutors: N. Zanghi and N. Pinamonti

- Analysis of the mathematical and physical conditions which ensure the analyticity of a two-point function of a free scalar field on a cosmological background

- 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

Ongoing and future research

- Thermalisation of small quantum systems (with Goldstein, Lebowitz, Tumulka) and applications to quantum thermodynamics (with P. Solinas).

- Emergence of probabilities in relational formulations of quantum mechanics and quantum gravity (with Goldstein and Dürr).

- Analysis of the solutions of the semiclassical Einstein equation in the case of dynamical blackhole to better understand the thermodynamical aspects of BH dynamics (with Verch (Leipzig), Gottschalk (Wuppertal))

- study of equilibrium states for integrable models like the two-dymensional sine gordon model in 2D (with Rejzner (York), Bahns (Göttingen))

- study of Bose Einstein condensate with methods of pAQFT to better understand the interplay of Goldstone theorem with infrared singularities at finite temperature (with Fredenhagen (Hamburg), Brunetti (Trento))

- Extension of Connes distance to the Lorentzian signature, in the light of previous work of Moretti, Franco, Wrochnal, Besnard (with Tommasini).

- Study of gauge theories, their quantization and analysis of the algebraic-geometrical structures that are at the base of the Becchi-Rouet-Stora and Batalin-Vilkovisky approaches (Marco Bernini).