
Part of the project Search for Quantum spacetime in Black Hole QNM spectrum and Gamma Ray Bursts.

## Related topics:

Quantum spacetime, black hole quasinormal modes, gravitational waves, quantum gravity phenomenology, gamma ray bursts, singularities of spacetime, Planck scale physics, black holes entropy, Hawking radiation, grey body factors, the information paradox, QFT on quantum spaces, noncommutative geometry, generalized symmetries, modified gravity, Lorenz violating theories, GUP inspired black holes, nonlinear electrodynamics.

## Invited speakers

- Kumar S. Gupta (Saha Institute of Nuclear Physics, Kolkata)
- Salvatore Mignemi (Dipartimento di Matematica, Università di Cagliari)
- Hamid Mehdipour (Department of Physics, College of Basic Sciences, Lahijan Branch, Islamic Azad University)
- Sebastián Franchino-Viñas (Departamento de Física, Facultad de Ciencias Exactas Universidad Nacional de La Plata)
- Tomislav Terzić (University of Rijeka, Faculty of Physics)
- Bruno Carneiro da Cunha (Departamento de F´ısica, Universidade Federal de Pernambuco)
- İzzet Sakallı (Physics Department, Eastern Mediterranean University)
- Ana Bokulić (PMF, Zagreb)

## Organizing committee:

- Anđelo Samsarov (Ruđer Bošković Institute, Zagreb)
- Tajron Jurić (Ruđer Bošković Institute, Zagreb)
- Ivica Smolić (PMF, Zagreb)
- Kumar Sankar Gupta (Saha Institute of Nuclear Physics, Kolkata)

## Technical support:

- Danijel Pikutić (Ruđer Bošković Institute, Zagreb)

## Contact e-mail:

- Anđelo Samsarov: asamsarov@irb.hr
- Tajron Jurić: tjuric@irb.hr

# Quantum aspects of spacetime and gravity

05 - 09 September 2022 at RBI, Zagreb, Croatia

Lecture Hall, Ivan Supek Wing (first wing)

## List of talks

- *Izzet* ***Sakalli***(4h lectures);

**Lectures on the thermal and gravitational radiations of black holes from analytical perspectives**

*Abstract:*
This series of graduate courses, in which we will deal with the thermal and gravitational radiation of black holes with analytical methods, will be explained with a pedagogical content in general. Especially black hole thermodynamics, Hawking radiation, greybody factors, quasinormal modes, black hole bomb, and area/entropy quantization of black holes will be explained via some specific black holes. Through these lectures, it is aimed that the audience will understand the relevant subjects thoroughly and inspire their future studies.

- *Tomislav* ***Terzic***(2h talk);

**Recent advancements in measuring Lorentz invariance violation with Cherenkov telescopes**

*Abstract:*
Cherenkov telescopes are instruments optimised for detection of very high energy (VHE, E > 100 GeV) gamma rays from astrophysics sources. They play a crucial role in testing possible consequences of Quantum Gravity (QG), such as violation or deformation of Lorentz symmetry. In both cases, the photon dispersion relation is modified, making the photon group velocity energy dependent, and possibly modifying kinematics and dynamics of electromagnetic interactions. These tiny effects are vastly below the sensitivity of present-day laboratories. However, if real, they could be measured using VHE gamma rays of astrophysical origin. Cosmological distances that they cross serve as a natural amplifier for the QG effects. While no deviations from the special relativistic predictions have been detected, strong constraints have been set on modified photon dispersion relations. In this session we will explain the process of testing implications of modified photon dispersion relations on VHE gamma rays using Cherenkov telescopes. We will cover different stages from observations, Cherenkov telescopes' data analysis, statistical methods employed, and finally setting constraints on the QG energy scale.

- *Sebastian Franchino-* ***Vinas***(1h talk);

**Quantum aspects of Snyder space**

*Abstract:*
In this talk I'll review some recent results regarding quantum aspects in Snyder space, including vacuum energies, scalar and fermionic wave equations, as well as a possible effective approach to a quantum field theory.

- *Kumar S.* ***Gupta***(1h talk);

**Black Hole Entropy and Quantum Information Scrambling**

*Abstract:*

A model first proposed by Rafael Sorkin to study black hole entropy and area law is generalized to describe an out of equilibrium scenario. Certain parameters of the model are made time dependent and the system is analyzed under various quench protocols. It is shown that under multiple quenches and in the thermodynamic limit, the system exhibits signatures of equilibration and thermalization, even when it is integrable. The out-of-time-ordered correlators (OTOC) in the same limit indicate scrambling of quantum information in this model.

- *Bruno Carneiro da* ***Cunha***(4h lectures);

**The monodromy method for black hole scattering**

*Abstract:*
I will summarize recent developments in the calculation of quasi-normal modes for static and axisymmetric black holes using techniques in conformal field theory and integrable systems. In the first part I will introduce the relevant mathematical structure, namely monodromy properties of solutions of ordinary differential equations in the complex plane and the accessory parameter problem, and how to efficiently solve them. In the second part I will focus on applications, dealing mostly with scalar fields on the generic rotating Kerr-AdS black hole in 5 dimensions, and the generic spin perturbations of Kerr black holes in four dimensions.

- *Salvatore* ***Mignemi*** (1h talk);

**The Snyder model and its generalizations**

*Abstract:*
We present the basic aspects of Snyder model both from a geometric and algebraic point of view. We also discuss some of its generalizations, in particular its formulation on a curved spacetime.

- *Hamid* ***Mehdipour***(2h talk);

**Teleparallel Black Holes in nonlinear electrodynamics models with Dyonic Configuration**

*Abstract:*
General Relativity (GR) is the most credible theory of gravity. However, it fails to describe gravity on a large scale. Much work has been done in modified gravity to reach the necessary features to support the observations mostly in the realm of cosmology. The so-called teleparallel equivalent of General Relativity (TEGR) is the first alternative formulation of GR that was developed soon after Einstein's gravity theory. This lecture considers a static, spherically symmetric spacetime in the context of the teleparallel equivalent of General Relativity coupled to the matter content from nonlinear electrodynamics (NED) supported by gauge invariant Lagrangians, seeking the feasibility of achieving nonsingular solutions. In this setup, the well-known NED solutions, i.e., the Bardeen and Hayward black holes (BHs) are first examined. Then, some specific dyonic configurations, involving both radial electric and magnetic fields, in the teleparallel gravity framework are analyzed. For the special case of a Born-Infeld NED theory, a generalized dyonic Reissner-Nordstrom (RN) solution is obtained in terms of the radial coordinate which exhibits a singular behavior at the origin. Nonetheless, the appearance of a naked singularity is impossible in the adopted Born-Infeld (BI) spacetime. The location and size of horizons depend on the BI parameter, leading to the concept of a hairy BH. However, at infinity, it is not distinguishable from a dyonic RNBH characterized only by global charges such as ADM mass, electric charge, and magnetic charge.

- *Ana* ***Bokulic*** (1h talk);

**No-go theorems for gravitating nonlinear electromagnetic fields**

*Abstract:*
Nonlinear electrodynamics is a broad term referring to various nonlinear generalizations of Maxwell's theory, usually defined by Lagrangians depending on two quadratic electromagnetic invariants. In the context of gravitational theory, our focus is on the interplay between the geometry of spacetime and the properties of nonlinear electromagnetic fields. Precisely, we discuss two different classes of no-go theorems that can be established when nonlinear electromagnetic fields are coupled to gravity. Motivated by the canonical result from Einstein-Maxwell theory, we prove two no-soliton theorems for spacetimes with nonlinear electromagnetic fields. Namely, in Einstein-Maxwell theory, strictly stationary, regular, asymptotically flat spacetime cannot support a nontrivial electromagnetic field. We show that the same conclusion holds for nonlinear electromagnetic fields, up to exotic stealth field configurations. A further question is whether black hole singularities can be cured within nonlinear electrodynamic theories. Bronnikov has noticed several constraints on the prospect of regularizing spherically symmetric spacetimes sourced by nonlinear Lagrangians depending on one electromagnetic invariant. We complement Bronnikov's no-go theorems by inspecting a larger class of Lagrangians, those depending on both electromagnetic invariants. Our results significantly narrow down the possibility of regularization using physically plausible Lagrangians.

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| 10-11 | **10:30**opening | Sakalli | Cunha | Cunha | Mehdipour |
| 11-12 | Sakalli | Sakalli | Cunha | Cunha | Mehdipour |
| 12-13 | Sakalli | break | break | break | break |
| 13-14 | break | Mignemi | Vinas | discussion | Bokulic |
| 14-15 | Terzic | Gupta | discussion | discussion | closing |
| 15-16 | Terzic | | | | |