# Workshop on Black Holes and Holographic Superconductivity

April 11, 2025

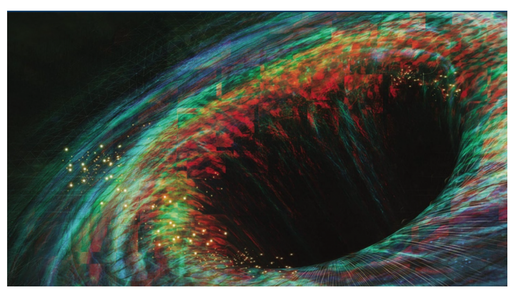
Instituto de Física Ing. Luis Rivera Terrazas
Benemérita Universidad Autónoma de Puebla

## Participants

- Manuel de la Cruz López (IF, BUAP)
- Alfredo Herrera Aguilar (IF, BUAP)
- Gustavo González Juárez (IF, BUAP)
- Naveena Kumara A. (Rudjer Bošković Institute)
- Jhonny Ariel Herrera Mendoza (Universidad Nacional Autónoma de Honduras)
- Julio Alberto Méndez Zavaleta (Universidad Veracruzana)
- Sergio Patiño López (ICN, UNAM)
- Daniel Martínez Carbajal (ICN, UNAM)

## Scope

The workshop aims to develop new avenues of research in General Relativity and its relevance to the construction of holographic models of superconductivity, discuss recent developments, and come up with new ideas that could lead to potential new collaborations. Experts in the field will present some of their recent work.



## Schedule:

**8:15-8:30**
**Opening ceremony**
**Felipe Pérez Rodíguez**
**Institute of Physics, Director**

**8:30-9:20**
***Transport Coefficients in Topological Gauss-Bonnet Black Holes***
**Julio Alberto Méndez Zavaleta**

In this talk, we present a novel class of nonlinearly charged five-dimensional black holes with non-standard horizon topologies. After characterizing their fundamental gravitational and thermodynamic aspects, we explore the implications for dual condensed matter systems emerging from these geometries. In particular, we examine how the interplay between nonlinear electrodynamics and the topology of their horizons affects transport and diffusion properties in holographic conductors.

**09:20-10:10**
***Black Holes and Noncommutativity***
**Naveena Kumara A.**

In this talk, I will present aspects of my recent research on noncommutative black hole physics, focusing on two distinct approaches to noncommutative gravity: geometric and gauge-theoretical. First, I will explore the dynamics of gravitational perturbations within the frameworks of Hopf algebra and noncommutative differential geometry. Particular emphasis will be placed on the impact of noncommutativity on the quasi-normal modes of the Schwarzschild black hole, which may be interpreted as a potential signature of quantum gravity. In the second part, I will discuss the construction of noncommutative black holes from a gauge-theoretical perspective, employing the Seiberg-Witten map, which gives rise to several noncommutative black hole toy models.

**10:10-11:00**
***Implications of black hole rotation and anisotropy on holographic superconductivity***
**Jhonny Ariel Herrera Mendoza**

In this talk, I will present the construction of a holographic model for a type-II superconductor employing a spinning and anisotropic black hole background. We discuss how rotation and anisotropy shape the properties of the dual superconductor model, suggesting a compelling relation between the rotation of a black hole and quasiparticle damping effects in a superconducting material.

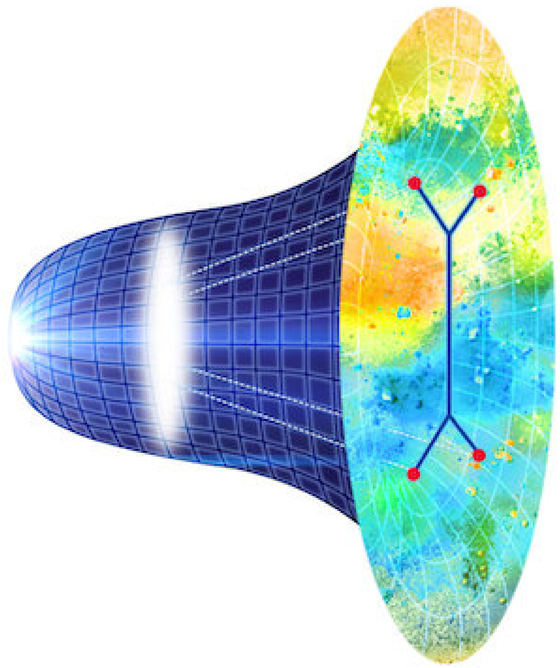
**11:00-11:50**
***Noncommutative AdS Black Hole and the IR holographic superconductor***
**Manuel de la Cruz López**

We construct a noncommutative (NC) $AdS_4$-charged black hole with a planar horizon topology and study in detail the thermodynamic structure of this scenario. Focusing on the $AdS_2$ structure near the horizon, we find a novel effective curvature radius with dependency on an NC cutoff. Then, we explore the holographic superconducting system in terms of the nearness from the cutoff. The behavior of the magnetic field in the deep IR geometry is studied, and we found the upper critical magnetic fields of a dual type-II superconductor in the canonical and grand canonical ensembles. The condensation in the form of hair is studied in terms of the bound states of the associated Schrödinger potential of the scalar field, interpreted as the dual to the density of Cooper pairs. The NC effects increase the hair formation due to a steeper $AdS_2$ throat comparable to the commutative case. Finally, we obtain the effective IR scalar field equation on the near horizon and near extremal NC Schwarzschild $AdS_2$ geometry and confirm that NC effects promote bound states that the commutative version forbids.

**11:50-12:10**
***Discussion***

## Organizing Committee

- Manuel de la Cruz López
- Alfredo Herrera Aguilar



## Where

The workshop will be held online at the following link:
https://meet.google.com/jun-vymw-wej

Starting at 8:15 AM UTC-6, Méico