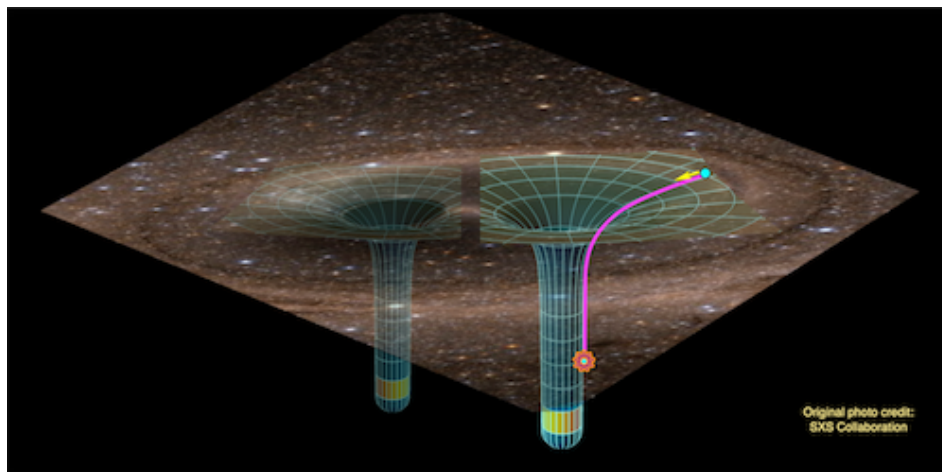


# BLACK-HOLE MICROSTRUCTURE



## Rapport sur les contributions

ID de Contribution: 1

Type: **Non spécifié**

## How to Spot Microstructure in the Wild

*lundi 7 juin 2021 11:30 (1h 15m)*

The advent of gravitational waves and black hole imaging has opened a new window into probing the horizon scale of black holes. An important question is whether string theory results for black hole physics can predict interesting and observable features that current and future experiments can probe. I will give a brief overview of the relevant observational experiments, before reviewing this exciting new field of gravitational black hole phenomenology from the perspective of fuzzballs. I will discuss what we can learn from the phenomenological study of known fuzzball geometries, what our current limitations are, and how future developments in fuzzballs physics will be crucial for the further development of this field.

<https://www.youtube.com/watch?v=ghZHE9wX8Kg>

**Orateur:** MAYERSON, Daniel

ID de Contribution: 2

Type: **Non spécifié**

## Black Holes, Unscripted

*lundi 7 juin 2021 14:00 (1 heure)*

Black Holes occupy a special place in the fascination of astronomers and physicists. From the most speculative mathematical physicist, to the most sensible radio astronomer, everyone has their own narrative of what lies within a black hole, based on their own preconceptions. As an alternative, I will outline an empirical and agnostic roadmap for probing black hole physics, by combining elements of quantum mechanics, general relativity, and astrophysical observations.

<http://www.youtube.com/watch?v=fm7r9jJKf3g>

**Orateur:** AFSHORDI, Niayesh

ID de Contribution: 3

Type: **Non spécifié**

## How does a black-hole microstate ringdown?

*lundi 7 juin 2021 15:30 (1 heure)*

The quasinormal-mode spectrum of a horizonless compact object can differ significantly from that of the corresponding classical black hole. However, the time response can be initially very similar if the object is sufficiently compact. A generic smoking gun of the absence of a classical horizon is the presence of echoes in the late-time ringdown. The echo delay time and morphology depend crucially on the properties of the object down to its potential well. Most of the echo analyses so far have considered toy or phenomenological models. I will present recent results on the ringdown phenomenology for a class of multicenter geometries describing the microstates of a static BPS black hole. The numerical method is based on numerical-relativity simulations of a test scalar field propagating on these geometries and can be applied to any stationary microstate, including non-BPS ones.

<https://youtu.be/cYAoByDykTE>

**Orateur:** PANI, Paolo

ID de Contribution: 4

Type: **Non spécifié**

## **Panel: Distinguishing Microstructure from Black Holes**

*lundi 7 juin 2021 17:15 (1h 15m)*

Iosif Bena (moderator), Massimo Bianchi, Daniel Mayerson, Geoff Penington

<https://www.youtube.com/watch?v=0BO-p58Pypc>

**Orateurs:** BENA (MODERATOR), Iosif; PENINGTON, Geoff; BIANCHI, Massimo; MAYERSON, Daniel

ID de Contribution: 5

Type: **Non spécifié**

## **Black Hole Microstates in Holography and Worldsheet CFT**

*mardi 8 juin 2021 11:30 (1h 15m)*

In this talk I will review recent progress on two topics. The first topic is the holographic description of heavy configurations in supergravity, in which holography can provide a microscopic interpretation of a supergravity solution as describing a particular pure black hole microstate. Recent results have enabled holographic studies with improved precision for supergravity solutions such as superstrata. The second topic is worldsheet models that describe stringy features of black hole microstates. These features include the fine microstructure of the bound state and an additional time delay of certain probes, beyond that which is visible in supergravity.

<https://www.youtube.com/watch?v=Z3Qm8BzMyJE>

**Orateur:** TURTON, David

ID de Contribution: 6

Type: **Non spécifié**

## The CFT Dual of a Tidal Force

*mardi 8 juin 2021 14:00 (1 heure)*

It was demonstrated that a string probe falling radially within a superstrata geometry would experience tidal forces. These tidal forces were shown to excite the string by converting its kinetic energy into motion along the transverse directions. Using the AdS/CFT correspondence we seek to understand this behavior from the perspective of the dual D1D5 CFT. To study this process we turn on an interaction of the theory which is described by a deformation operator. This deformation includes a twist operator which joins and separates 'effective' strings of the D1D5 system. We start with an initial state which is dual to the probe moving within the superstrata geometry. We then use two deformation operators to compute transition amplitudes between this state and a final state that corresponds to excitations along the transverse directions. We show that for long timescales this amplitude grows as  $t^2$  with  $t$  being the amount of time for which the deformation operators are turned on. We argue that this process in the CFT is suggestive of the tidal effects experienced by the probe propagating within the dual superstrata geometry.

<https://youtu.be/DIM5oz3AWHc>

**Orateur:** HAMPTON, Shaun

ID de Contribution: 7

Type: **Non spécifié**

## Black hole microstates vs the additivity conjectures

*mardi 8 juin 2021 15:30 (1 heure)*

I will argue that at least one of the following statements must be true: either (a) extensive violations of quantum information theory's "additivity conjectures" exist or (b) there exists a set of "disentangled" black hole microstates that can account for the entire Bekenstein-Hawking entropy (up to at most a subleading  $O(1)$  correction). Possibility (a) would be a significant result in quantum communication theory, demonstrating that entanglement can enhance the ability to transmit information much more than has currently been established. More interestingly given the topic of this conference, option (b) would provide new insight into the microphysics of black holes. In particular, the disentangled microstates would have to have nontrivial structure at or outside the black hole horizon, assuming the validity of the quantum extremal surface prescription for calculating entanglement entropy in AdS/CFT.

<https://youtu.be/fyx4ZHR9N6E>

**Orateur:** PENINGTON, Geoff



ID de Contribution: 8

Type: **Non spécifié**

## An overview of Jackiw-Teitelboim gravity and applications

*mardi 8 juin 2021 17:15 (1h 15m)*

We will give an overview of recent developments in two dimensional Jackiw-Teitelboim (JT) gravity in asymptotically AdS, and applications. The talk will be separated into two parts. First we will review perturbative quantum effects in JT gravity, which are a good approximation of low energy physics for a variety of systems including near-extremal black holes in higher dimensions and SYK-like models. These effects become large at small enough temperatures modifying the spectrum and correlators. Still, they are not enough to capture the unitarity of the black hole spectrum. In the second part of the talk, focusing on pure gravity, we will review non-perturbative effects originating from spacetime wormholes and sum over topologies. This leads to a concrete duality between a large class of two dimensional dilaton-gravity theories in asymptotically AdS and a disorder average over boundary Hamiltonians, described by random matrix theory.

[https://youtu.be/Yjr\\_k7d2lvE](https://youtu.be/Yjr_k7d2lvE)

**Orateur:** TURIACI, Joaquin

ID de Contribution: 9

Type: **Non spécifié**

## Interpolating between multi-center solutions

*mercredi 9 juin 2021 11:30 (1 heure)*

We study interpolation between two multi-center microstate geometries in 4d/5d that represent Lunin-Mathur geometries with circular profiles. The interpolating solution is a Lunin-Mathur geometry with a helical profile, and is represented by a 2-center solution with a codimension-2 source. The interpolating 2-center solution exhibits interesting features such as some of the charges being delocalized, and some of the charges getting transferred from the codimension-2 center to the other, codimension-3 center as the interpolation proceeds. We also discuss the spectral flow of this entire process and speculate on the relevance of such solutions to understanding general microstates of 3-charge black holes.

<http://www.youtube.com/watch?v=UakWIQ1dmmU>

**Orateur:** SHIGEMORI, Masaki

ID de Contribution: **10**

Type: **Non spécifié**

## Comments on the Page curve for Hawking radiation

*mercredi 9 juin 2021 15:00 (1 heure)*

We will review the ideas that lead to the computation of the Page curve for Hawking radiation. We will discuss what aspects of the black hole information problem this addresses and which ones remain to be understood.

<http://www.youtube.com/watch?v=-vHrjKGgtMk>

**Orateur:** MALDACENA, Juan

ID de Contribution: 11

Type: **Non spécifié**

## Contrasting the fuzzball and wormhole paradigms for resolving the black hole information paradox

*mercredi 9 juin 2021 16:00 (1 heure)*

We summarize the information paradox and how the fuzzball paradigm resolves the paradox. We note that the small corrections theorem implies that any alternative to fuzzballs must involve long-distance nonlocality. We comment on some aspects of the wormhole paradigm, trying to pinpoint the kind of nonlocalities implied by such an approach.

<https://www.youtube.com/watch?v=-vHrjKGgtMk&t=4215s>

**Orateur:** MATHUR, Samir

ID de Contribution: 12

Type: **Non spécifié**

## Panel: Islands

*mercredi 9 juin 2021 18:15 (1h 15m)*

Moderator: Emil Martinec

[http://www.youtube.com/watch?v=m\\_1mzZ9tlvc](http://www.youtube.com/watch?v=m_1mzZ9tlvc)

**Orateurs:** MARTINEC (MODERATOR), Emil; STANFORD, Douglas; MALDACENA, Juan; MATHUR, Samir

ID de Contribution: 13

Type: Non spécifié

## Bubble Bag End: a Non-BPS Floating Brane's Tale

*jeudi 10 juin 2021 16:30 (1 heure)*

Using the Weyl formalism, we will describe a new mechanism for constructing smooth bubbling geometries in the non-BPS regime. The solutions require at least 6 dimensions, they are static, axially symmetric and asymptotic to four-dimensional Minkowski flat dimensions plus extra compact dimensions. They are generated by a set of harmonic functions like their BPS cousins but are sourced by rods. We will study solutions consisting of a large number of smooth microscopic bubbles, so-called Bubble Bag Ends. These solutions resemble a geometry with a naked singularity that is resolved by the chain of bubbles. The  $S^2$  sphere suddenly opens in the vicinity of the singularity but closes at the bubble loci where the space-time caps off smoothly. We will embed the solutions in string theory and discuss a new non-BPS floating brane Ansatz that allows the construction of static horizonless bubbling geometries.

<https://youtu.be/CpjWvOLVkoo>

**Orateur:** HEIDMANN, Pierre

ID de Contribution: 14

Type: **Non spécifié**

## Superstrata and Microstrata

*jeudi 10 juin 2021 14:30 (1h 15m)*

I will review that current status of superstrata as a description of BPS microstructure and summarize some of the open problems. I will also describe some new progress in the construction of “microstrata:” non-extremal analogues of superstrata.

<https://youtu.be/nvPqTqNs00U>

**Orateur:** WARNER, Nicholas

ID de Contribution: **16**

Type: **Non spécifié**

## **Wormholes and microstructure**

*jeudi 10 juin 2021 18:00 (1 heure)*

<https://youtu.be/yQ0Q58FvsHM>

**Orateur:** SHENKER, Steve



ID de Contribution: 18

Type: **Non spécifié**

## Scrambling in rotating BTZ from CFT

*vendredi 11 juin 2021 14:00 (1 heure)*

Slow scrambling has recently been discussed in the context of extremal BTZ black holes and associated microstate geometries. This talk addresses the CFT origin of this phenomenon and of related results for more general rotating BTZ black holes.

<https://youtu.be/qo8c3xXOvyE>

**Orateur:** CRAPS, Ben

ID de Contribution: 19

Type: **Non spécifié**

## AdS3/(worldsheet)CFT2

*vendredi 11 juin 2021 15:30 (45 minutes)*

Perturbative string methods provide a wealth of insights into AdS3/CFT2 duality, and its generalization to little string theory. An overview of these methods will be given as well as a survey of results obtained to date.

<http://www.youtube.com/watch?v=IHjQdvGu-mc>

**Orateur:** MARTINEC, Emil

ID de Contribution: **20**

Type: **Non spécifié**

## **Maldacena Response**

*mercredi 9 juin 2021 17:00 (15 minutes)*

**Orateur:** MALDACENA, Juan

ID de Contribution: 21

Type: **Non spécifié**

## Mathur Response

*mercredi 9 juin 2021 17:15 (15 minutes)*

**Orateur:** MATHUR, Samir

ID de Contribution: 22

Type: **Non spécifié**

## **Panel: Scrambling and Tidal Disruption**

*vendredi 11 juin 2021 18:00 (1h 15m)*

<https://youtu.be/jHp1WVBdYww>

**Orateurs:** WARNER (MODERATOR), Nicholas; CRAPS, Ben; SONNER, Julian; HAMPTON, Shaun

ID de Contribution: 23

Type: **Non spécifié**

## AdS3 with no BTZs

*vendredi 11 juin 2021 16:45 (45 minutes)*

I will describe AdS3 string theory with NS fluxes in a regime where the AdS3 radius of curvature is smaller than the string scale. The asymptotic density of states consists of highly excited fundamental strings rather than BTZ black holes. I will present evidence that the CFT dual to this string theory is a symmetric product orbifold with a linear dilaton “block” CFT, with a deformation that introduces a wall that cuts off the strong coupling region.

<https://youtu.be/Z4r7M6ft1xg>

**Orateur:** BALHAZAR, Bruno