Publications

Journal articles, conferences, talks, preprints.

- 2025 A chapter in the book: The Black Hole Information Paradox
- 2024 Thesis
    - Special distinction
- Papers
    - Papers 2023
    - Papers 2024

2025 A chapter in the book: The Black Hole Information Paradox

Alejandro Perez and Sami wrote a chapter:

Planckian Discreteness and the Resolution of the BH Information Puzzle

https://link.springer.com/chapter/10.1007/978-981-96-6170-1_14

in the following book: :

https://link.springer.com/book/10.1007/978-981-96-6170-1

Alejandro mentionned: "J'ai écrit une petite phrase au début du chapitre pour Sami. Je vois que la phrase et aussi visible en ligne sous le résumé

PS: il y a un prix Nobel (Gerard t'Hooft) parmi les auteurs (voir la liste des chapitres en bas de la page avec le lien ci dessus)"

During his PhD defense, Sami compared the black hole information paradox to a book going up in smoke, and asked whether it would then be possible to recover all the information contained in that book.



2024 Thesis

2024 Thesis

Special distinction

amU
Aix Marseille Université

NNT : 2024AIXM0001

THÈSE DE DOCTORAT

Soutenue à AMU — Aix-Marseille Université
le 10 décembre 2024 par

Sami VIOLLET

Study of perturbative and non perturbative properties of quantum black holes

Discipline
Physique et Sciences de la Matière

Spécialité
Physque Théorique et Mathématique

École doctorale
ED 352 Physique et Sciences de la Matière

Laboratoire/Partenaires de recherche
Centre de Physique Théorique
(CNRS UMR 7332)

Composition du jury

Kristina GIESEL Professeure, Université FAU	Rapporteure
Aurélien BARRAU Professeur, LPSC	Rapporteur
Ivan AGULLO Professeur, LSU	Examinateur
Daniel SUDARSKY Professeur, UNAM	Examinateur
Etera LIVINE Directeur de recherche, ENS de Lyon	Président du jury
Alejandro PEREZ Professeur, CPT	Directeur de thèse
Simone SPEZIALE Directeur de recherche, CPT	Invité

CPT

L'Ecole Doctorale
Physique et Sciences de la Matière
distingue les travaux de thèse de
Sami VIOLLET
pour leur grande qualité et leur impact dans la recherche sur les trous noirs quantiques

Thèse soutenue le 10 décembre 2024 dans la spécialité
Physique Théorique et Mathématique
au Centre de Physique Théorique, Marseille

amU
Centrale Méditerranée

Papers

Papers 2023

Alejandro Perez, Salvatore Ribisi and Sami Viollet *Universe, 9(2):75, 2023* : arXiv:2301.03951

Modelling quantum particles falling into a black hole: the deep interior limit

Authors: Alejandro Perez, Salvatore Ribisi, Sami Viollet

Abstract: In this paper we construct a solvable toy model of the quantum dynamics of the interior of a spherical black hole with falling spherical scalar field excitations. We first argue about how some aspects of the quantum gravity dynamics of realistic black holes emitting Hawking radiation can be modelled using Kantowski-Sachs solutions with a massless scalar field when one focuses on the deep interior region $r \ll M$ (including the singularity). Further, we show that in the $r \ll M$ regime, and in suitable variables, the KS model becomes exactly solvable at both the classical and quantum levels. The quantum dynamics inspired by loop quantum gravity is revisited. We propose a natural polymer-quantization where the area a of the orbits of the rotation group is quantized. The polymer (or loop) dynamics is closely related with the Schroedinger dynamics away from the singularity with a form of continuum limit naturally emerging from the polymer treatment. The Dirac observable associated to the mass is quantized and shown to have an infinite degeneracy associated to the so-called ε-sectors. Suitable continuum superpositions of these are well defined distributions in the fundamental Hilbert space and satisfy the continuum Schroedinger dynamics. △ Less

Submitted 10 January, 2023; **originally announced** January 2023.

Alejandro Perez and Sami Viollet: arXiv:2307.10254

Discreteness Unravels the Black Hole Information Puzzle: Insights from a Quantum Gravity Toy Model

Authors: Alejandro Perez, Sami Viollet

Abstract: The black hole information puzzle can be resolved if two conditions are met. Firstly, if the information of what falls inside a black hole remains encoded in degrees of freedom that persist after the black hole completely evaporates. These degrees of freedom should be capable of purifying the information. Secondly, if these purifying degrees of freedom do not significantly contribute to the system's energy, as the macroscopic mass of the initial black hole has been radiated away as Hawking radiation to infinity. The presence of microscopic degrees of freedom at the Planck scale provides a natural mechanism for achieving these two conditions without running into the problem of the large pair-creation probabilities of standard remnant scenarios. In the context of Hawking radiation, the first condition implies that correlations between the {\em in} and {\em out} Hawking partner particles need to be transferred to correlations between the {\em microscopic degrees of freedom} and the {\em out} partners in the radiation. This transfer occurs dynamically when the {\em in} partners reach the singularity inside the black hole, entering the UV regime of quantum gravity where the interaction with the microscopic degrees of freedom becomes strong. The second condition suggests that the conventional notion of the vacuum's uniqueness in quantum field theory should fail when considering the full quantum gravity degrees of freedom. In this paper, we demonstrate both key aspects of this mechanism using a solvable toy model of a quantum black hole inspired by loop quantum gravity.

△ Less

Submitted 24 October, 2023; **v1** submitted 17 July, 2023; **originally announced** July 2023.

Comments: arXiv admin note: text overlap with arXiv:2301.03951, arXiv:1703.09149

Johannes Münch, Alejandro Perez, Simone Speziale and Sami Viollet arXiv:2212.06708

3. arXiv:2212.06708 [pdf, other] gr-qc hep-th doi 10.1088/1361-6382/accccd

Generic features of a polymer quantum black hole

Authors: Johannes Münch, Alejandro Perez, Simone Speziale, Sami Viollet

Abstract: Non-singular black holes models can be described by modified classical equations motivated by loop quantum gravity. We investigate what happens when the sine function typically used in the modification is replaced by an arbitrary bounded function, a generalization meant to study the effect of ambiguities such as the choice of representation of the holonomy. A number of features can be determined without committing to a specific choice of functions. We find generic singularity resolution. The presence and number of horizons is determined by global features of the function regularizing the angular components of the connection, and the presence and number of bounces by global features of the function regularizing the time component. The trapping or anti-trapping nature of regions inside horizons depends on the relative location with respect to eventual bounces. We use these results to comment on some of the ambiguities of polymer black hole models. △ Less

Submitted 24 May, 2023; **v1** submitted 13 December, 2022; **originally announced** December 2022.

Comments: 32 pages, many figures

Papers 2024

Sami Viollet

Employing the effective field theory treatment of general relativity to constraint quantum black hole models. *To appear 2024*

Alejandro Perez and Sami Viollet

Decoherence without dissipation in a quantum field theory model. *To appear 2024*