

# **Qiongyu Qi**

Institute for Theoretical Physics, University of Amsterdam

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## **EDUCATION**

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### **Southern University of Science and Technology (SUSTech)**

*Bachelor of Science in Physics, Sep.2021-Jul.2025*

### **Shanghai Institute for Mathematics and Interdisciplinary Sciences (SIMIS) in Fudan University**

*Visiting Student, Feb.2024-Sep.2024*

### **University of Amsterdam (Universiteit van Amsterdam, UvA)**

*Graduate Student, Sep.2025-Jul.2027 (expected)*

## **RESEARCH EXPERIENCE**

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### **Non-Unitary Conformal Field Theory at Critical Point**

*Advisor: Prof. Wenjie Ma, Shanghai Institute for Mathematics and Interdisciplinary Sciences, May.2024-Aug.2024*

- It is well known that for a system (in 2d) with Hermitian Hamiltonian at critical point, it usually governed by a unitary Conformal Field Theory with central charge greater than 0. But for non-Hermitian system, it usually governed by Non-unitary Conformal Field Theory. To test the central charge  $c$  of a system, we usually have two methods, entanglement entropy (or  $c_{eff} = c - 24\Delta_{min}$  in non-unitary CFT) and free energy. But when consider non-Hermitian SSH model at critical point, these two methods will give different results.

### **Entanglement Entropy and Thermodynamics of Dynamical Black Holes**

*Cooperators: Dr. Weizhen Jia (CUHK) and Prof. Christina Gao (SUSTech), Mar.2025-Sep.2025*

- We explore the thermodynamic and entanglement properties of dynamical black holes based on the recently proposed dynamical black hole entropy by Hollands-Wald-Zhang. We provide a direct proof that, under first order perturbations, the dynamical black hole entropy in any  $f(R)$  theory equals the Wald entropy evaluated on the generalized apparent horizon. Then, we compute the gravitational entanglement entropy explicitly using both the event horizon and the apparent horizon as the entangling surfaces, and show that only the apparent horizon prescription reproduces the correct dynamical black hole entropy satisfying the physical process first law. Furthermore, we reinterpret the generalized second law by identifying the modified von Neumann entropy as the matter entanglement across the (generalized) apparent horizon. This allows us to express the total entropy as the renormalized generalized entropy evaluated on this surface for both Einstein's gravity and  $f(R)$  gravity.

### **Holographic Interpretation of the Dynamical Black Hole Entropy**

*Cooperators: Dr. Antony J. Speranza, University of Amsterdam, Sep.2025-present*

- In 2024 Hollands-Wald-Zhang derived a dynamical black hole entropy (in first-order perturbation), and we want to give a holographic interpretation of this entropy in higher curvature gravity. We found that in  $f(R)$  gravity the outer the entropy of the generalized apparent horizon (which agrees with the entropic marginally outer trapped surface in  $f(R)$  gravity) is the Wald entropy. This agrees with the results derived by Hollands-Wald-Zhang, we prove this statement in both Einstein frame and original frame (we call it  $f(R)$  frame). And our result is non-perturbative. Now we are trying to find the boundary dual of the outer entropy.

## **PUBLICATION**

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- [1] Weizhen Jia, Qiongyu Qi, and Christina Gao. “Entanglement Entropy and Thermodynamics of Dynamical Black Holes”. In: (Sept. 2025). arXiv: 2509.05700 [hep-th].

## **RESEARCH INTERESTS**

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**AdS/CFT Correspondence, Black Hole Physics and Quantum Gravity**

## SUMMER SCHOOL

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### The 3rd and 4th Frontier Summer School of Strings, Fields, and Holography at Yau Center of Southeast University

*Summer School Student, Aug.2023 and Aug.2024*

#### • Lectures in Summer School

Lectures about AdS/CFT, Black Hole information, BPS Black Hole microstates in AdS, Generalized Symmetry, SYK Model and it's dual to Gravity, Supersymmetry and Conformal Bootstrap.

## PROFESSIONAL SKILLS

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### Programming

- Mathematica and LaTeX

### Mathematics

- I have basic Mathematics ability, such as basic differential geometry and Riemann geometry, basic Algebra (group theory, representation theory, Lie group, and basic commutative algebra) and basic topology (simple homology and cohomology theory).

### A Solid Base on Quantum Field Theory

- I'm familiar with many topics in Quantum Field Theory, from basic textbook ones (those in Peskin & Schroeder, Sidney Coleman or Weinberg I and II) to some advanced topics, such as anomalies and instantons, supersymmetry (from basic supersymmetry algebra to Super Yang-Mills), 2-dimensional conformal field theory (those in Philippe Di Francesco & Pierre Mathieu & David Senechal Vol I), higher dimensional conformal field theory and lattice quantum field theory (those in Heinz J. Rothe Lattice Gauge Theories). Besides, I'm also familiar with the basics of string theory (those in Polchinski I and some basic superstring theory).

### General Relativity

- I have a solid base on General Relativity and Cosmology.

## LEADERSHIP

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### Club of Mathematics and Physics

*Minister Jan.2023-Jan.2024*

- I organized many seminars, including seminars on differential geometry, quantum field theory, and other topics in mathematics and physics.
- I collaborated with the successor ministers to organize the first, the second and the third workshop on mathematics and theoretical physics. This student-organized initiative seeks to facilitate interinstitutional academic exchange and will feature a diverse array of presentations encompassing topics such as Cosmology, Quantum field theory, Quantum information, Quantum gravity, and various topics in Mathematics. We have invited numerous professors from the Chinese high-energy physics and theoretical physics community, as well as outstanding student presenters from all over the world. See these websites for more information: <https://sustech-cmp.github.io/workshop/2025-winter/> and <https://indico.itp.ac.cn/event/342/>

## AWARDS & HONORS

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### Honor Class Membership in Mathematics

*2021-2023*

### Third Class Scholar

*2022*