

GPPU PROGRESS REPORT

“QUANTUM INFORMATION AND GENERAL RELATIVITY”



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MY RESEARCH

- “Gravity” is classically described by Riemann geometry (General Relativity).
 - How to know this spacetime structure ?
 - ➡ Let us consider a quantum field theory on the spacetime.
 - ➡ $g_{\mu\nu} \propto \lim_{x \rightarrow y} \frac{\partial}{\partial x^i} \frac{\partial}{\partial y^j} (G(x, y)^{\frac{2}{2-D}})$
- Then we can know the spacetime structure by measurement on Green function in principle. (but **not realistic**)
- What effects does curved spacetime have to quantum fields?
(for example, Hawking’s blackhole information loss paradox)
 - ➡ In particular, the relations between quantum information concept (e.g. entanglement) and gravity are being studied.

SO FAR, AND PLAN

- So far, two papers have been published

- ① Information on a collapsing star in a black hole evaporation process.

- [[Phys. Rev. D 101, 024003](#)] published in this January.

- I presented this research in RQI-N-2019 (Relativistic Quantum Information-North) in Taiwan.

- ② Duality in the dynamics of detectors in conformally related spacetimes.

- [[Phys. Rev. D 101, 085017](#)] published in this April.

- (\Rightarrow collaboration with Waterloo University Group!!)

- Goal (in GPPU term)

- Construction of the detectors network.

- \rightarrow Understanding the relation between the spacetimes structure and quantum information.

- Problem

- What quantum information characterize the spacetime (efficiently)?

- \rightarrow We don't know what should be measured.

PROGRESS TO DATE

- We find how to storage information on black evaporation process. (using toy model)
→ already published in PRD
- We find the duality between “entanglement harvesting” on conformally related spacetimes.
(this work is collaboration with Waterloo univ. group)
→ already published in PRD
- **Now** we consider the “horizon charge” which may be detected.
→ We develop the method to find them (so far this has been done by trial and error...)
→ There is a new symmetry.

I'm writing paper about this and will upload on arXiv soon !

OVERSEAS WORK

So far ...

I went to the Waterloo University in Canada and worked with Achim Kempf group.

→ Collaboration work is done!!!

Next...

- RQI-N 2020 in Greece on June. (cancelled→Maybe Online)
- I'm going to work with Waterloo Group (Eduardo Martín-Martínez) about spacetime detectors. (Online Works)