GPPU PROGRESS REPORT
"QUANTUM INFORMATION AND GENERAL RELATIVITY"

Takeshi Tomitsuka (D2)
Particle theory and cosmology group

➤ Our spacetime is described by Riemann geometry (i.e. metric $g_{\mu\nu}$ (+boundary)).

➤ How to know this spacetime structure ?

➡ Let us consider a quantum field theory on the spacetime.

➡ $g_{\mu\nu} \propto \lim_{x \to y} \dfrac{\partial}{\partial x^i} \dfrac{\partial}{\partial y^j} (G(x, y)^{\frac{2}{2-D}})$

thus if we let a detector run on the spacetime and measure the green functions of "ALL POINTS", we can know exact structure of spacetime in principle. (Not realistic !!!)

➤ We are going to construct the "Detectors Network".
- Detectors connect (interact) each other and exchange their information.
- Some machine learning technics to optimize interactions (field to detector & detector to detector) including detectors trajectory.

SO FAR, AND PLAN

➤ So far
  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.
  (⟹collaboration with Waterloo University Group!!)

➤ Goal (in GPPU term)
  Construction of the detectors network.
  →Understanding the relation between the spacetimes structure and quantum information.

➤ Problem
  What quantum information characterize the spacetime (efficiently)?
  →We don't know what should be measured.

➤ 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" generated by general coordinate transformation which may be detected.
(on-going work)

OVERSEAS WORK

So far …

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

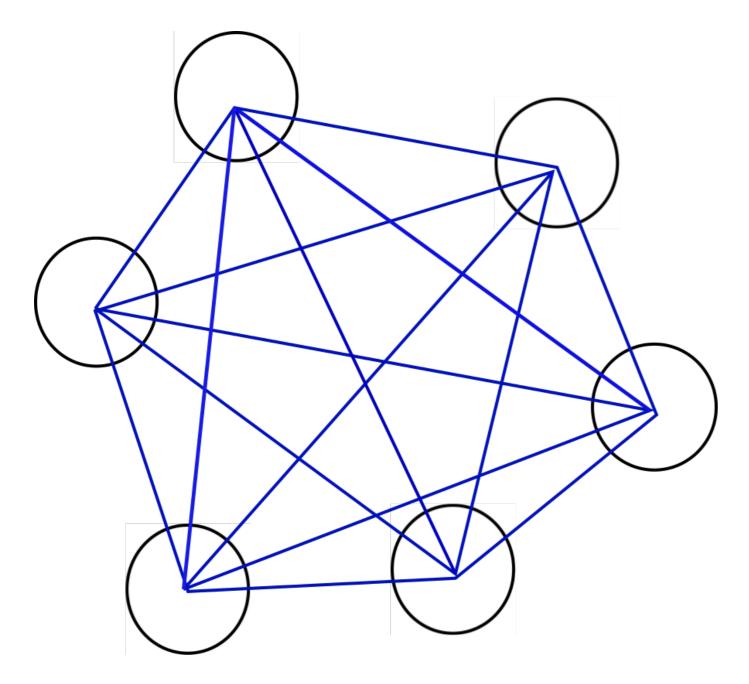$\Rightarrow$ Collaboration work is done!!!

Next…

➤ RQI-N 2020 in Greece on June. (???→Maybe Online)

➤ I want to work with Waterloo Group (Eduardo Martín-Martínez) about Machine Learning for spacetime detector.   (Online Works)

BACKUP

PICTURES

Detector network