# Testing quantum gravity on a quantum computer

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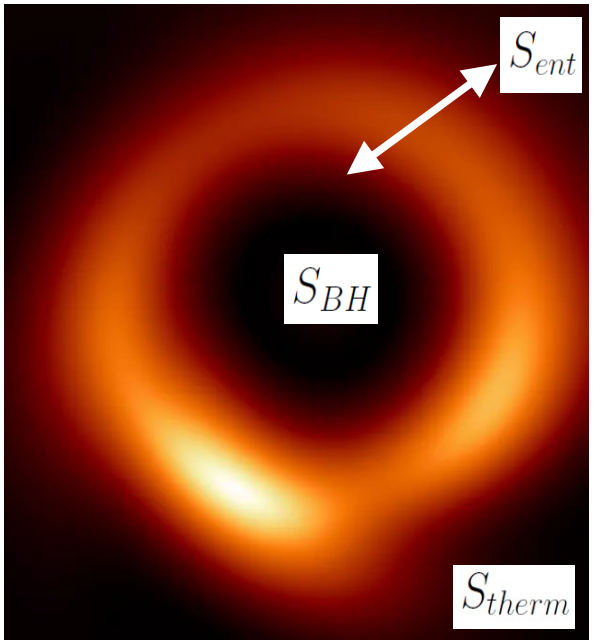



INFN online meeting
December 14th , 2023

# PLAN

* A turn of history

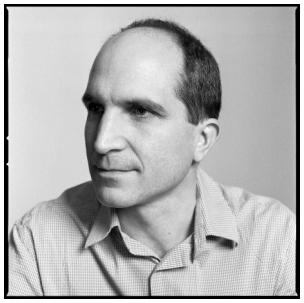
* Two directions to use a QC:
    1. the analog way (example)
    2. the correspondence way (example)

* Open problems for 2:
- firmly establish a (the) correspondence
- build an appropriate QC

# *A turn of history

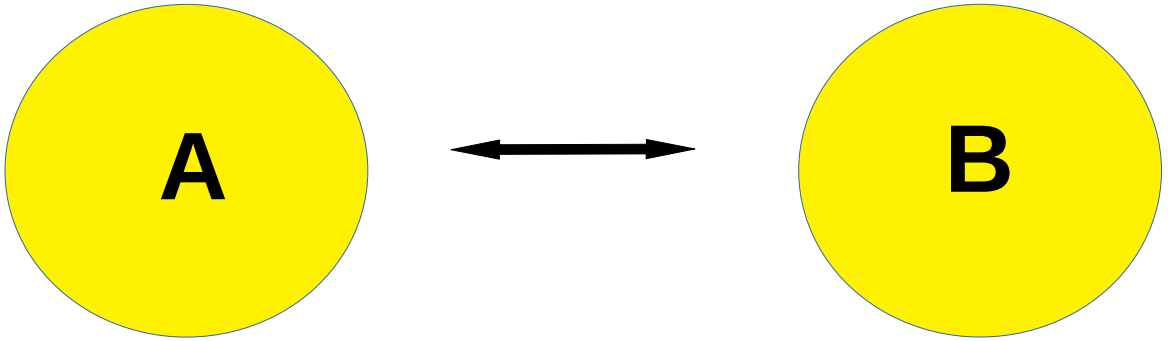
The current understanding is that gravity is *emergent*:

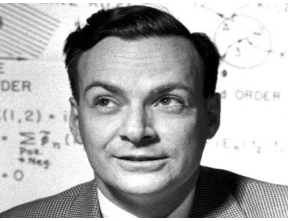
from an underlying spin foam



from a QFT one dimension less

This gave a powerful toolbox of correspondences, dualities, symmetries, that map



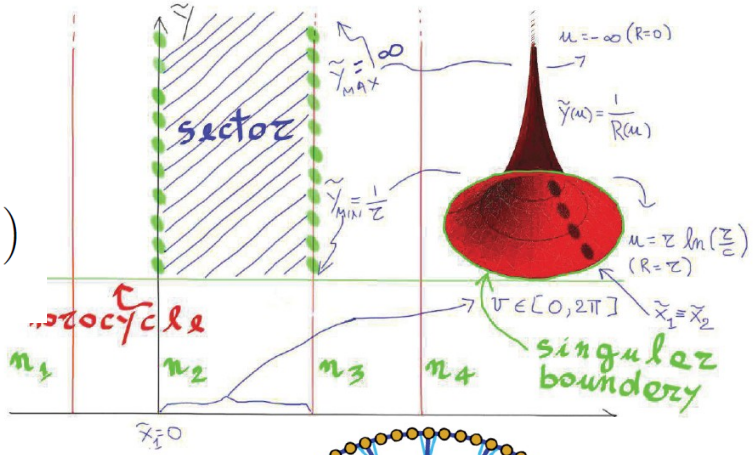



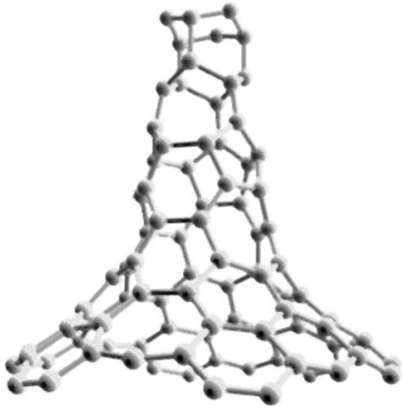
Quantum system

Gravity system

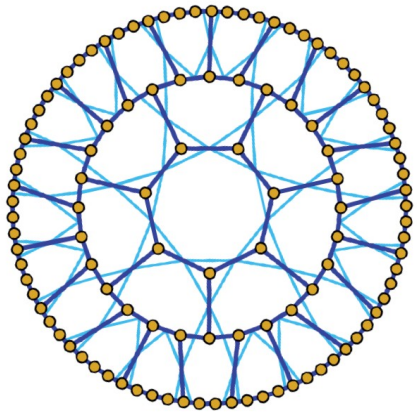
# * Two directions to use a QC: 1. the analog way (example)

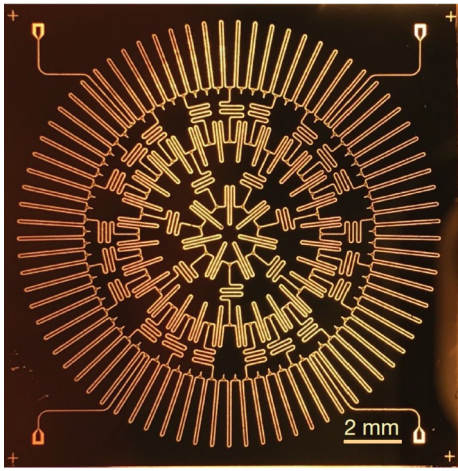
$$dl^2 = \frac{1}{\tilde{y}^2}(d\tilde{x}^2 + d\tilde{y}^2)$$



$$dl^2 = \frac{d\tilde{x}^2 + d\tilde{y}^2}{(1 - \tilde{x}^2 - \tilde{y}^2)^2}$$

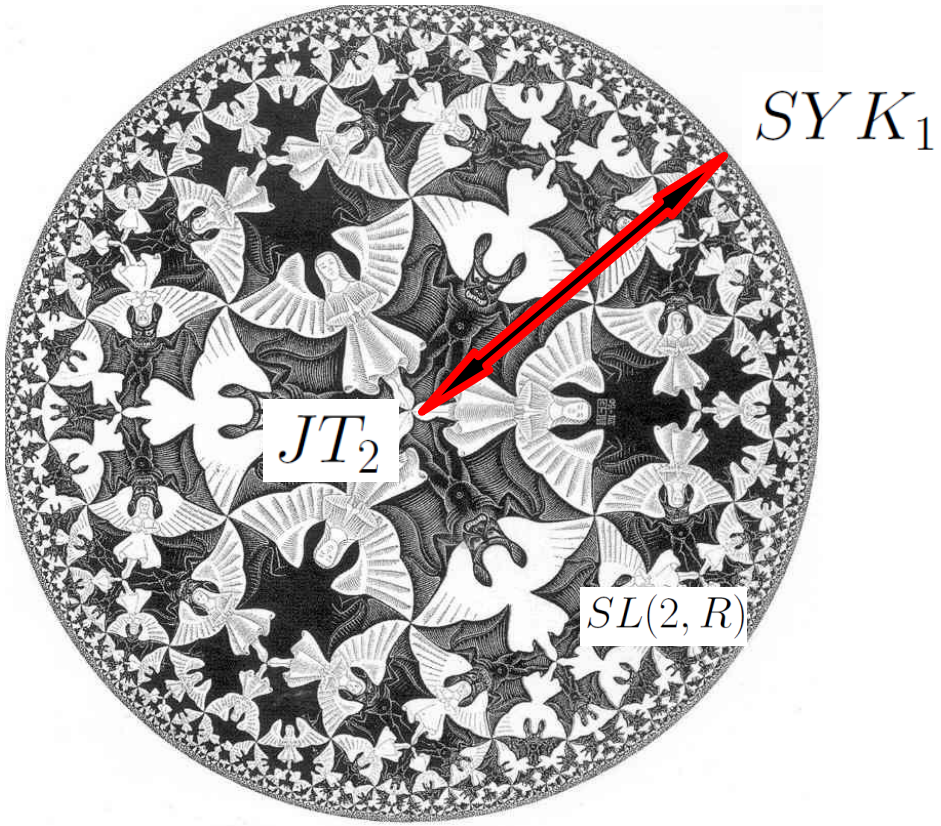


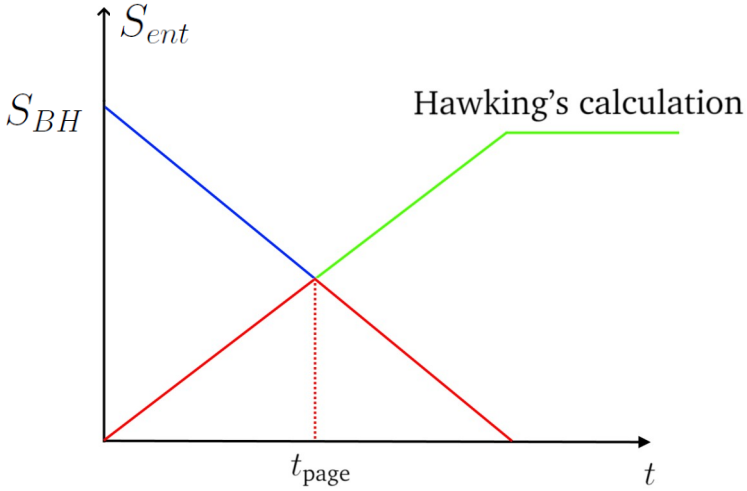


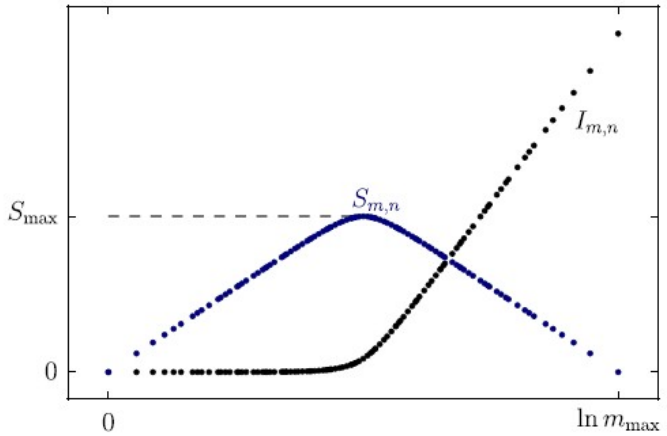

(Magic) quantum circuit of superconducting qubits, coupled to microwave resonators

A J Kollár, M Fitzpatrick and A A Houck, Nature 571 (2019) 45

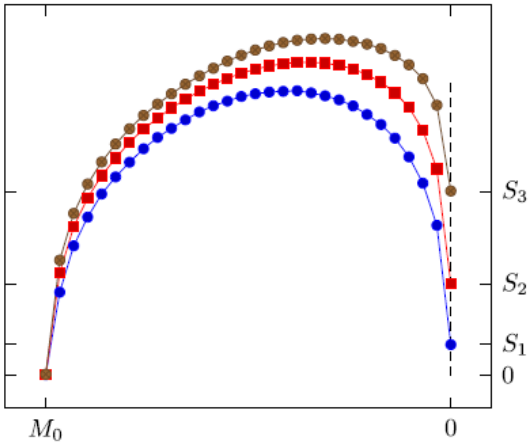
# * 2. the correspondence way (example)



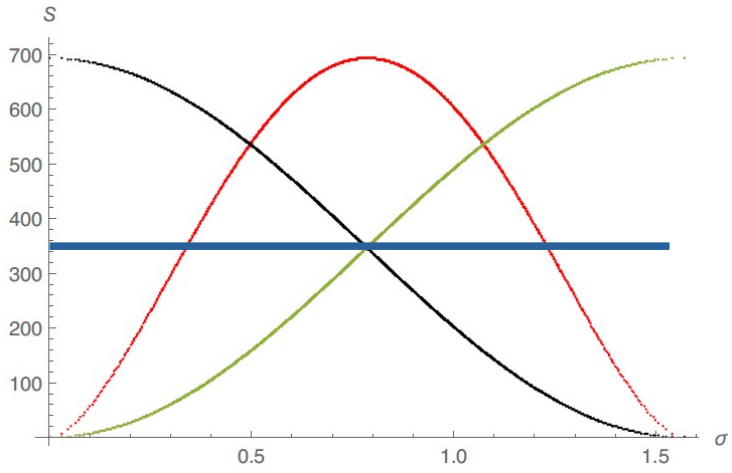



**Page?**




**Modified Page?**



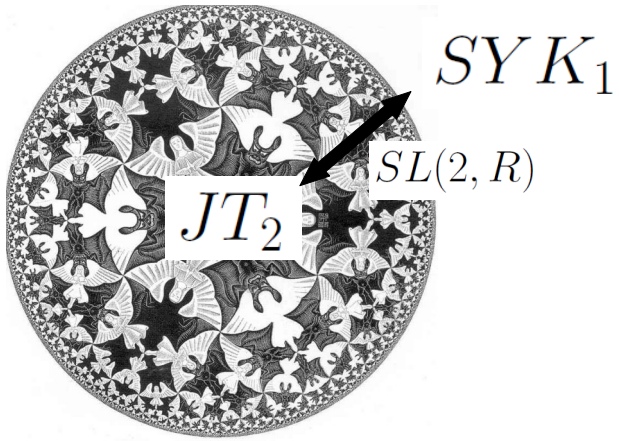

**Grumiller?**

**Else ?**

# * Open problems for 2: - firmly establish a (the) correspondence

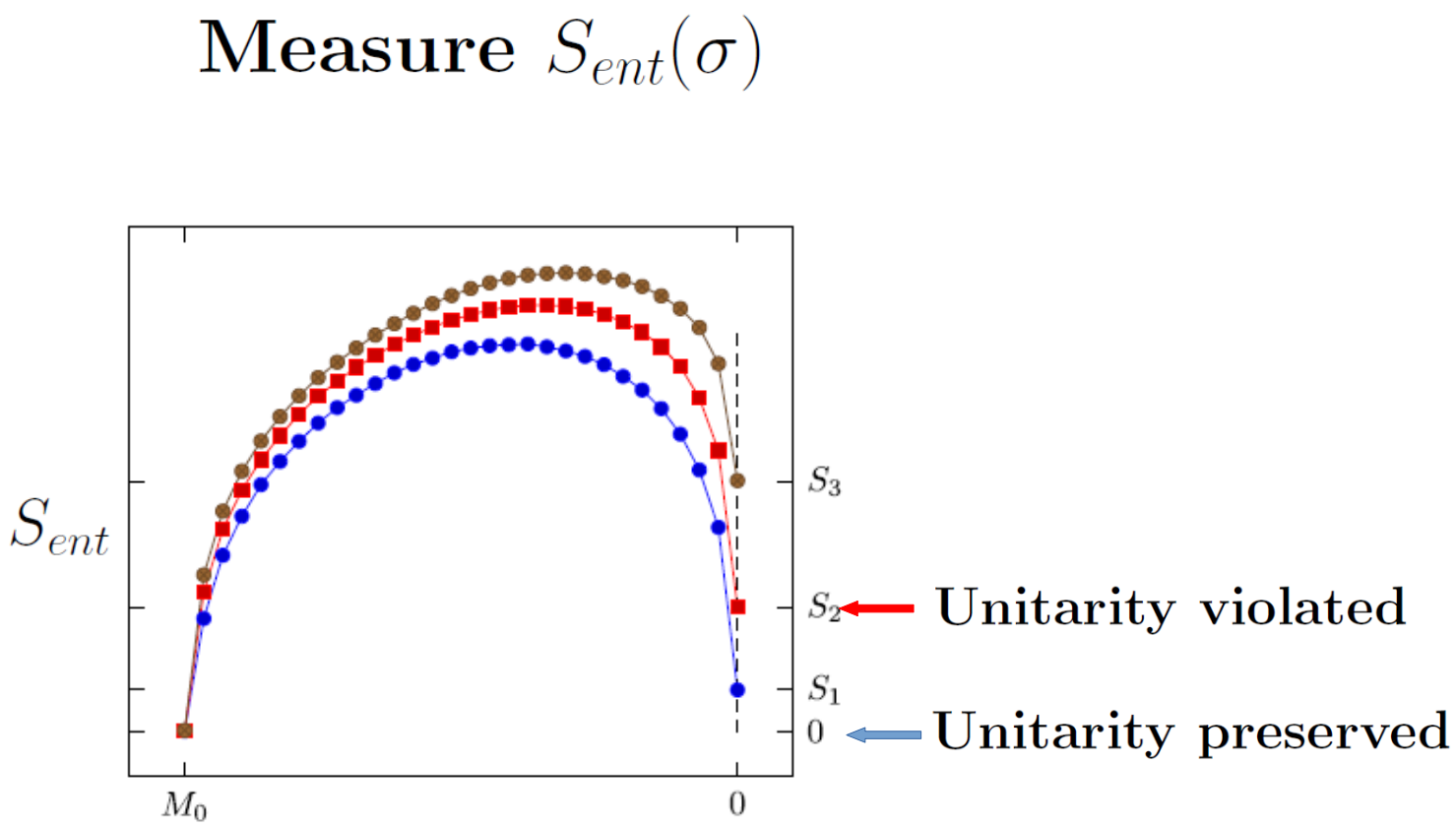
**This is an example of** $AdS_2/CFT_1$ **correspondence**

**In the large** $N$ **limit** ($G_N \sim 1/N$), **for** $T \to 0$




**Same (Schwarzian) action**
**Same correlators (enjoying** $SL(2,R)$ **symmetry)**
**Same thermodynamics, e.g.**

$$\frac{\partial \mathcal{S}}{\partial \mathcal{Q}} = 2\pi \mathcal{E}$$

**(important role of quantum chaos,** $\lambda_{Lyap} \leq 2\pi T/\hbar$)

# * Open problems for 2: build an appropriate QC