The holographic dual of gravity as a quantum resource

Alioscia Hamma[1]

1. *Università degli Studi di Napoli Federico II, Dipartimento di Fisica* Ettore Pancini, Via Cinthia 21, 80126 Napoli, Italy

Abstract: Quantum complexity comes from the interplay of two quantum resources, entanglement and non-stabilizerness. This interplay is captured by non-local stabilizer entropy. This quantity represents also the holographic dual of gravitational back-reaction.

A long-standing problem in quantum information is: what are the resources that make quantum computers able to perform computational tasks in a way that outperforms any kind of classical Turing machine? The flip side of the same question is: what makes quantum mechanics so hard to simulate? The two resources that set quantum computers apart are entanglement and non-stabilizerness [1]. Without either of them, quantum computers cannot perform any advantageous algorithm over classical devices. In particular, non-stabilizerness is the resource allowing to distill universal gates from a given quantum state and the cost of simulating a quantum state on a classical computer. Despite decades of groundbreaking theoretical and experimental advance in the field, the resource theory for quantum advantage and complexity remains still an open, and, to some extent, elusive problem. Recently, the unique computable and measurable monotone quantifying non-stabilizerness has been introduced [2] as Stabilizer Entropy (SE).

In [3], we have proposed as a general monotone ecompassing both entanglement and SE the so-*called non-local SE*. We show that non-local SE is well captured by conditions of non-flatness of the entanglement spectru. In this way, we can show, in the context of AdS-CFT, that non-local SE is the holographic dual of gravitational back-reaction. anti-flatness is a necessary condition for gravitational back-reaction. In this way we can assert a fundamental equivalence:

Gravity = Quantum Complexity.

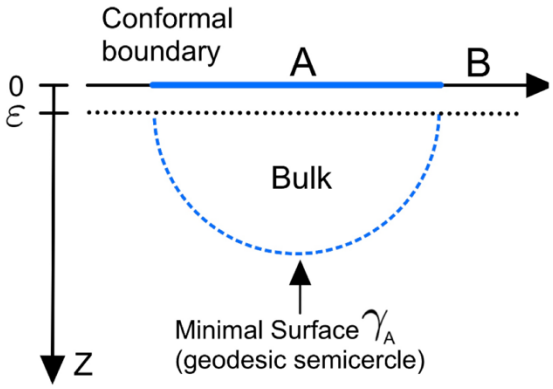

Fig. 1 The Holographic dual of gravity, conceived as back-reaction, is the linear response to a perturbation of the minimal surface, which is the tension of the membrane and it is a measure of non local stabilizer entropy.

References

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