Time and holographic principle

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Bekenstein used such thought experiments to show that a black hole should have an entropy proportional to the area of its event horizon in Planck units. In fact, it has been proven that semiclassical gravity is insufficient to account for this entropy.

Consider the definition of time as the ratio of entropy entanglement of a sphere to its radius.

$$t = \frac{Gh}{c^4}\frac{S(R)}{R}$$

In an arbitrary closed surface, the entropy is folded in parts along the surface.

$$\delta t = \frac{Gh}{c^4}\frac{\delta S(R)}{R}$$

Hence the definition of time on any closed surface in space. Time determined on any closed surface through entropy entanglement, defined on distance from the origin.

$$t = \frac{Gh}{c^4}\oint_A \frac{dS}{R}$$

This time definition is more universal for entropy entanglements for any arbitrary closed surface. This is very similar to the analogy. Time behaves as a potential, and entropy as a charge.
Such a definition provides an opportunity to understand the occurrence of the space-time interval.

$$s^2 = (ct)^2 - R^2$$

Consider the interval where time is replaced as the ratio of entropy entanglement of the sphere to its radius.

$$s^2 = \left(l_p^2\frac{S}{R}\right)^2 - R^2$$

$$l_p^2 = \frac{Gh}{c^3}$$

Make a complex turn, where the interval takes the Euclidean form

$$s^2 = \left(l_p^2\frac{S}{R}\right)^2 + (iR)^2$$

This means the interval describes the distance in the complex space. And this space is a complex Hilbert space, since the product is temporary and spatial coordinates gives a dimensionless quantity, holographic entropy.

$$\Psi_{max} = e^{i\frac{S}{R}R} = e^{iS}$$

Thus, pseudo space-time arises as a direct distance in the maximum complex Hilbert space.

A more general time formula works approximately.

$$t = \frac{Gh}{4\pi c^4} \oint_A \frac{dS}{R}$$

In the case of a gravitational field or acceleration, the relation formula between time and the holographic entropy of the surface will be

$$\frac{\partial t}{\partial t} = \frac{Gh}{4\pi c^4} \oint_A \frac{d\left(\frac{\partial S}{\partial t}\right)}{R} = 1$$

In general, the surface integral for the production σ of holographic entropy is normalized and is equal to unity

$$\frac{Gh}{4\pi c^4} \oint_A \frac{d\sigma}{R} = 1$$

$$\sigma = \frac{\partial S}{\partial t}$$

This formula is more general and universal for any closed surfaces, than the Bousso limit and surface formula Takayanagi.

[1] T. Takayanagi, “Holographic Spacetimes as Quantum Circuits of Path-Integrations,” to appear in JHEP, arXiv:1808.09072 [hep-th].

[2] Bousso, Raphael. "The holographic principle". arXiv:hep-th/0203101.