Gravity and the entropy equation of a black hole

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Abstract

Based on Prof. Bekenstein and Prof. Hawking, the black hole maximal entropy[1], the maximum amount of information that a black hole can conceal, beyond its event horizon, is proportional to the area of its event horizon surface divided by quantized area units, in the scale of Planck area (the square of Planck length). This is a surprising result since it limits the amount of information bits that are concealed in a volume of space to the amount of Planck area units that can fit into its surrounding surface area and not into its volume. This lead to the holographic principle idea [2] by reducing our standard three dimensional (3D) space into a two dimensional space (2D). This paper will suggest a new approach in which we add extra dimensions and quantize our standard three dimensional space in order to explain this surprising result of the Hawking Bekenstein formula. From this new approach gravitational time dilation emerges leading towards the Einstein field equations.

Introduction

The Hawking Bekenstein equation of black hole entropy, limits the amount of the entropy in the volume of space within the event horizon to be proportional to the area of the event horizon divided by Planck's area (the square of Planck's length). Since any volume of space will contain less information than a black hole, the information in a sphere is limited by its surrounding surface divided by Planck area units. This means that the entire information bits in our observable universe is limited by its surrounding surface area divided by Planck area sized units. This lead to the idea that our observable universe is a two dimensional hologram spread on the surface of its surrounding sphere. The main problem with the holographic approach is, that it requires a two dimensional universe while based on our physical experience and measurements, we live in a symmetrical three dimensional space, isotropic and homogenous in all three dimensions. This paper suggests another approach in which we redefine our standard three dimensional space as quantized, local, Planck length sized three dimensional units "floating" in another non local three dimensional space that this paper will refer to as the grid dimension (figure 1). The non-local grid dimension can explain the non-locality of quantum entanglement, quantum tunneling, the Schrodinger wave equation and the quantum entanglement between the information in a volume of space and the information on the surface of its surrounding sphere (The Bekenstein- Hawking formula).

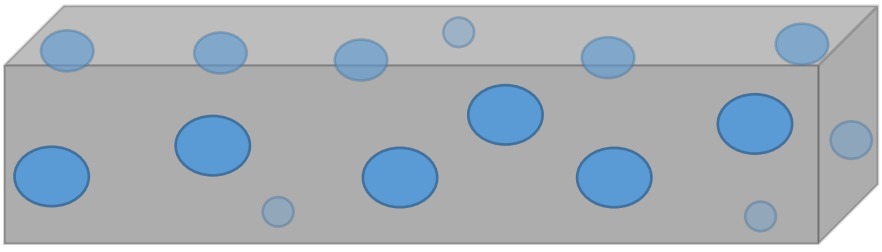

Figure 1: Like a Swiss cheese, the local standard space is quantized into space units in the size of Planck length in each dimension and is illustrated like floating blue bubbles in different distances. The gray void in which these bubbles float in, illustrates the non-local three dimensional extra grid dimension. The non-locality of the grid dimension enables non local quantum entanglement between any two separated quantized units of space. The non-locality of the grid dimension dictates that the information concealed in a volume of space will be projected to its surrounding surface. This is another way to explain the Bekenstein Hawking formula without giving up on our experience regarding an isotropic, symmetric, homogeneous, three dimensional space.

Conclusion

By quantizing space and adding a non-local grid like dimension we can explain the Hawking - Bekenstein information (entropy) formula without giving up our daily experience of a three dimensional, symmetrical, homogeneous and isotropic space. The non-locality features of the grid dimension model requires that the information within a sphere of space is entangled to its surrounding surface at all time spreading the information throughout the surrounding surface of the sphere. Due to energy conservation considerations, this entangled information on the surrounding surface of the sphere, comes in the form of the virtual particles that pop in and out of existence (the quantum fluctuations [3]). These quantum fluctuations can be measured by the Casimir effect [4] as a function of the gravitational field (the Casimir effect is expected to increase proportional to the increase in the gravitational field due to the increase of information projected to the surface of the sphere). The Heisenberg uncertainty principle [5] emerges from the quantum fluctuation projecting the concealed information within the sphere to its surrounding surface. During the phase in which the quantum fluctuations on the surface of the sphere rearrange themselves, until they fully project the information within the sphere, time as we define it stays still. Since our standard space is quantized to Planck length sized units and since all these units are entangled through the grid dimension, the number of information bits within a sphere is limited to the area of its surrounding surface divided by the area of a space unit which is the Planck area (the Hawking - Bekenstein information/entropy formula). As the number of information bits increase within the sphere and consequently on the surrounding surface of the sphere, the number of quantized space units who are not occupied by virtual particles at a specific moment decrease and it takes a longer time for the virtual particles on the surrounding surface of the sphere to re arrange themselves (to fluctuate) in a way that will not lose the total information within the sphere. This slowdown in the re arrangement of the quantum fluctuations is the gravitational time dilation. This leads to the idea that the rhythm of time on the surrounding surface of a sphere emerges as the quantum fluctuations on the surrounding surface of a sphere rearrange in a way that the projected information from within the sphere will not be lost (figure 2). Gravity emerges from the gradient in the rhythm of time throughout space-time as described by the Einstein general relativity equations. The grid dimension is an extra non local three dimensional space dividing our standard three dimensional space into quantized Planck sized three dimensional local units. The maximum speed for energy transportation, is limited for each pulse of Planck time, to one leap of Planck sized local space unit, and from this limit, the speed of light emerges. So by quantizing space time and adding the non-local grid dimension we get a holistic image that can explain the Bekenstein Hawking black hole information formula, the non-locality of quantum entanglement (“spooky action at a distance “ – Albert Einstein), the speed of light limitations, definition of time and gravity.

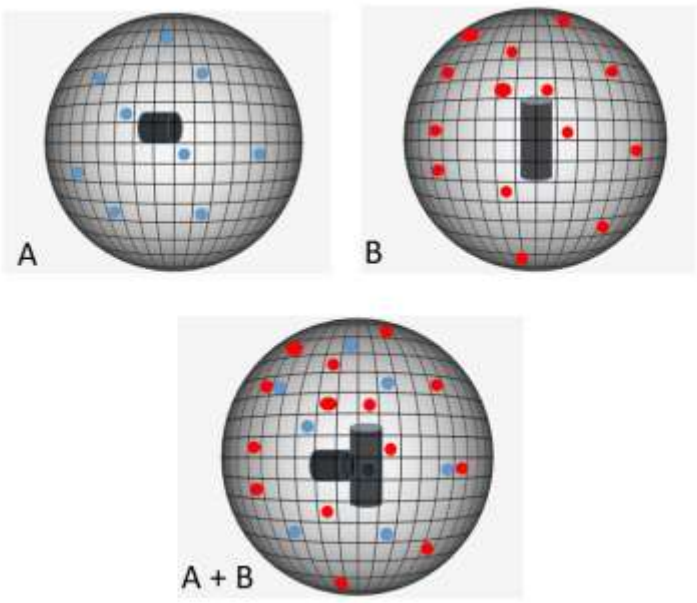

Figure 2: The grid dimension (illustrated as a black grid) entangles the information concealed within a sphere, with the quantum fluctuations of virtual particles on any surrounding surface of the sphere (illustrated as the blue and red dots). The white rectangles on the sphere represent the quantized units of our standard space-time. The rectangles with the dots are the occupied space units. The empty rectangles without the dots are the non-occupied space units. Like in the case of electrons in an atom which tend to fill their energy level bottom up, gravity curves space time connecting together mass A and mass B. When mass A and B connect they increase the amount of information which is spread on any joint surrounding surface of their sphere in the form of quantum fluctuations. As the information within the sphere increases, the number of quantized space units on the surface of the sphere which are not occupied with information decreases. This decrease is equivalent to a decrease in the degrees of freedom for rearranging the information during the quantum fluctuations. The quantum fluctuations on the surface of the sphere slow down due to the longer time needed to re arrange the fluctuations without losing the information concealed within the sphere. It is as if the quantum fluctuations need to rearrange a "puzzle" every time it fluctuates. As the "puzzle" becomes more complicated the longer it takes to fluctuate and coordinate all the pieces of the puzzle together without losing information. This slowdown in the quantum fluctuations is the gravitational time dilation. The gravitational time dilation curve space-time as described by Einstein's field equations. Based on Heisenberg uncertainty principle ($\Delta E * \Delta t \geq h$), as the time between fluctuations (Δt) increases , the energy of the quantum fluctuations (ΔE) decreases. Gravity tends to slow time and decrease the energy of the quantum fluctuations and it emerges from the quantized local space divided by the non-local grid dimension which are the Yin and Yang of space-time.

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