International Journal of
Science and Engineering Investigations vol. 7, issue 79, August 2018
ISSN: 2251-8843

A New Approach to the Holographic Principle

Eran Sinbar
YORAN Imaging
(eran@yoran-imaging.com)

Abstract- Based on Prof. Jacob Bekenstein, the black hole maximal entropy, the maximum amount of information that a black hole can absorb, beyond its event horizon is proportional to the area of its event horizon divided by 4 times the scale of Planck area (the square of Planck length). This unexpected result leads to the conclusion that information in a volume of space is limited by the surface area and not by the internal volume as expected [1].This lead to the unexpected idea called the holographic principle, in which the entire information in our 3D universe is projected through a thin, Planck scaled layer of quantized 2D hologram.This article will show a new approach to the holographic principle which can be tested and measured in the near future.

Keywords-*Holographic Principle, Vacuum, Virtual Particles, Planck's Area, Information Bits, Entropy*

I. INTRODUCTION

Prof. Bekenstein equation of black hole entropy, limits the amount of the entropy in the volume of space within the event horizon to the area of the event horizon divided by Planck's area (the square of Planck's length). Let's take for example a volume of space surrounded by a sphere and increase the amount of information bits (entropy) within this volume of space. At some point this volume of space will be saturated with information bits and will become a black hole and the surrounding sphere will become its event horizon. From this point on any added information bit will increase the area of its event horizon in the size of Planck's area. This leads us to the conclusion that the number of information bits (entropy) in a volume of space is limited to the area of its surrounding sphere divided by the Planck's area. This limitation on the amount of information kept in a volume of space based on its surrounding sphere area, lead to the holographic principle [2] in which the entire information in our 3D universe is projected through a thin, Planck scaled layer of a 2D hologram.

Since information is never lost and entropy always increases, we assume that when a black hole evaporates through its Hawking radiation [3], this radiation contains the black hole's latent information which is radiated back into space. Since Hawking radiation is based on the black hole's outer surface generation of virtual particles, near the event horizon, we assume that the entire information is located on the event horizon. On the other hand based on Einstein's field equations the entire information is located in the singularity point at the center of the black hole. These two annoying ideas that our 3D existence is actually a 2D hologram and the dual location of information in a black hole lead me to look for a new approach to the holographic principle ideas.

II. FLUCTUATIONS OF EMPTY SPACE AND THE HOLOGRAPHIC PRINCIPLE

Heisenberg's uncertainty in energy level for a short period of time comes in the form of virtual particle pairs of matter and anti-matter in empty space that pop in and out of existence. Their short existence can be measured directly through the Casimir effect. These virtual particles constitute the Hawking radiation. They carry the latent black hole information from the surface of the event horizon into the void of space during the evaporation process of the black hole. So let's conclude: The information of the black hole is located both in the singularity point as Einstein predicts, and on a thin layer on the surface of the event horizon as Hawking and Bekenstein predict. This surface information is radiated into space through virtual particles in the vacuum during the evaporation process of the black hole. The idea that information in a volume of space is limited to its boundary surface area lead to the Holographic theory.

III. THE INFORMATION STORAGE PRINCIPLE

In this paper we suggest a new approach in which for any 3 dimensional volume of matter (or energy) and for any outer surface of empty space that surrounds it, the virtual particles that pop in and out of existence on this 2D outer surface of empty space, will represent the information (or entropy) of the 3D volume of matter (or energy) within it (Fig. 1).

The same information, based on virtual particles that pop in and out of existence in empty space, will be found in all the surface areas of all the spheres that surround this specific volume of matter floating in empty space. We chose to show only 2 examples of spheres 1 and 2 but there are endless configurations. We will refer to that as the information storage principle.

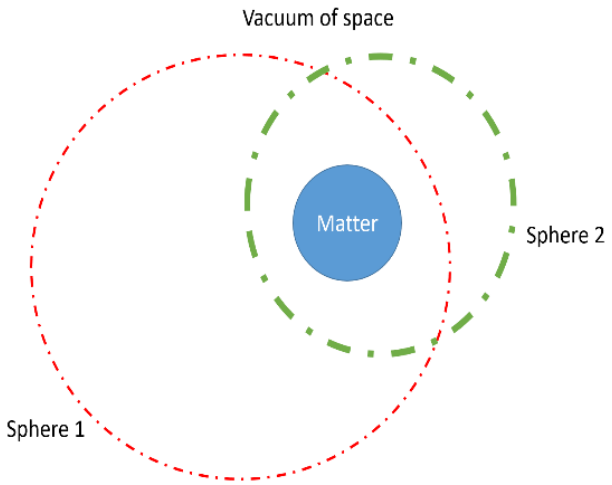

Figure 1. In this two dimension illustration of three dimensions of space, the information (or entropy) that defines a volume of matter (blue circle) is located on the surface of sphere1 and sphere 2 that surround it in empty space, in discrete bits of information in the size of Planck's area. The discrete information bits are the virtual particles that govern the empty space based on Heisenberg's uncertainty principle. The Morse code pattern of dots and dashes illustrate the information bits on the surface of the sphere. The line of sphere 2 was drawn wider than the line of sphere 1 to illustrate that information is more compressed in a smaller sphere .

IV. Proving by Experiment the Information Storage Principle.

We suggest the following experiment to prove the information storage principle: measure the Casimir effect [4] in a vacuum chamber near a collision of protons at the large hadron collider (Fig. 2) and compare it with the same Casimir effect without the collision of protons, or wait some relaxation time after the protons collision (Fig.3). We expect that near the huge source of energy and entropy during the collision, the surface around the collision in the vacuum will increase its virtual particles activity in order to store the entropy of the collision, and that will increase the measured Casimir effect.

V. Conclusion

We show a new approach to the Holographic principle where the information (entropy) bits of a 3D volume of matter (or energy) are stored as 2D bits in the size of Planck's area on any 2 dimensional surface of empty space surrounding this 3 dimensional volume of matter (or energy). These bits of information come in the form of virtual particles that are being generated and annihilated based on Heisenberg's uncertainty principle and can be measured through the Casimir effect.

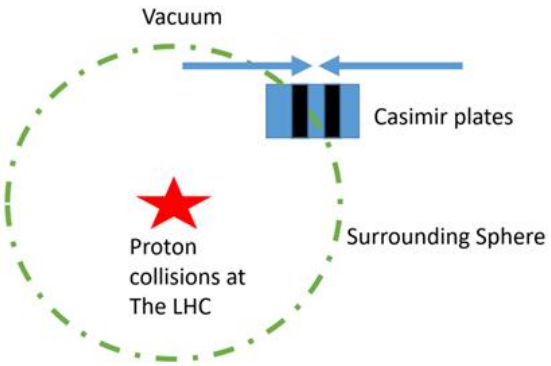

Figure 2. In this illustration we show that the measured Casimir effect on the surrounding sphere increases during a proton collision because of the increment in information in the form of increase in virtual particles activity .

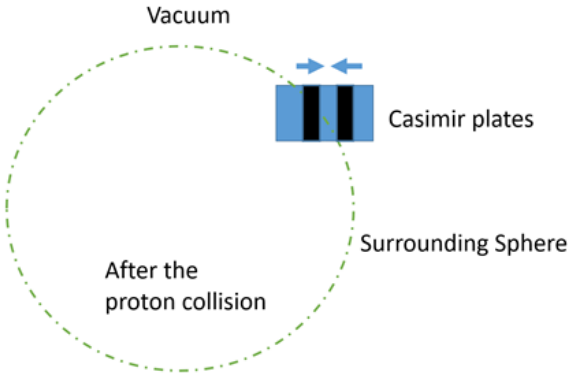

Figure 3. In this illustration we show that the measured Casimir effect on the same surrounding sphere decreases some time after the proton collision effect (relaxation time) ,because of the decrease in information in the form of decrease in virtual particles activity.

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