

The E. Witten conjecture about the entropy of black holes and the relationship of the monster group with string theory.

Angel Garcés Doz

October 28, 2022

angel1056510@gmail.com

Abstract

In 2007, E. Witten (<https://arxiv.org/abs/0706.3359>, [Three-Dimensional Gravity Revisited](#)) suggested that AdS/CFT correspondence yields a duality between pure quantum gravity in (2+1)-dimensional anti de Sitter space and extremal holomorphic CFTs. Pure gravity in 2+1 dimensions has no local degrees of freedom, but when the cosmological constant is negative, there is nontrivial content in the theory, due to the existence of BTZ black hole solutions. Extremal CFTs, introduced by G. Höhn, are distinguished by a lack of Virasoro primary fields in low energy, and the moonshine module is one example.

Part of Witten's proposal is that Virasoro primary fields are dual to black-hole-creating operators, and as a consistency check, he found that in the large-mass limit, the Bekenstein-Hawking semiclassical entropy estimate for a given black hole mass agrees with the logarithm of the corresponding Virasoro primary multiplicity in the moonshine module. In the low-mass regime, there is a small quantum correction to the entropy, e.g., the lowest energy primary fields yield $\ln(196883) \sim 12.19$, while the Bekenstein-Hawking estimate gives $4\pi \sim 12.57$.

It is demonstrated in this work in a theoretical-heuristic way, that E. Witten's conjecture about the entropy of black holes is precisely $\ln(196883)$.

Introduction

The general theory of relativity can not adequately describe the gravitational quantum properties of black holes; for the simple reason that the RG theory is a purely classical mathematical physical theory. Due to this fact, and there is not yet a quantum mechanical theory of gravity, it is necessary to use other alternative theories such as, for example, string theory. The mathematical successes

of this last theory and its consistency will not be enumerated. But it will be noted that it is the only theory that can most likely unify gravity with quantum mechanics. For this attempt of unification not only its theoretical development will suffice; otherwise, the development of experiments that can give us an empirical support that is verifiable and derivable from theoretical predictions will also be essential.

One among other alternative experiments; It could be the simulation in the laboratory of black holes, and measure the entropy of these simulations of black holes. Within a more refined version of these latter experiments one could pretend to measure and deduce the type of radiation emitted by these simulated black holes. The main problem with this type of simulations is the accuracy of their properties with real black holes. Our work focuses, mainly, on the entropy conjectured by E.Witten, or its dimensionless value expressed by $\ln(196883)$

On the other hand, a series of axioms will be introduced from which we will derive the main consequences. Some of these axioms be based on the absence of certain properties of black holes derived from the general theory of relativity and totally disagree with quantum mechanics.

The main incompatibility of the theory of GR is the existence of the singularity of a black hole. That is to say: the existence of a point entity of zero radius. This presumed singularity can not exist according to quantum mechanics; since according to Heisenberg's uncertainty principle for a zero-size radius, the uncertainty of the energy would be infinite. And we know perfectly well that infinities indicate that a theory fails in its limit of applicability. Therefore, the time space must necessarily be quantized to a limit size and that this limit will naturally be the Planck length.

We must ask ourselves why a black hole does not disappear by its own force of gravitational attraction and that by increasing its mass by capturing mass from its surroundings its surface increases; which is a measure of your entropy or amount of information, as is well known.

Our proposal to this question is that inside the black holes there is a compensatory repulsive force that maintains its size and increases it by engulfing mass from its surroundings. This repulsive force would be of the same nature as the repulsive force of the quantum vacuum, which manifests itself in the accelerated expansion of the universe and in the abnormally high speeds of rotation within galaxies.

All of the above would lead to a modification of gravity that would explain the quantum nature of black holes and the numerous gravitational effects not explained by the GR theory. Among these unexplained effects would be the discrepancies observed among the perihelios within the solar system. Another effect would be the abnormal annual increase of the Earth-Sun distance and the Earth-Moon distance. And evidently the abnormal speeds of rotation within the galaxies. All these effects could point to the repulsive nature of the quantum vacuum and derived from a quantum theory of gravitation that would include the GR in its classic limit; but also unify the aspects of quantum mechanics.

We must establish axioms or postulates that are of an elementary logic and that reconcile the quantum mechanics and the gravity treated from the point

of view of string theory. These elementary premises must be derived from the internal logic of string theory itself. On the other hand, when a black hole is formed, the information should not be lost; since the black hole is a previous transformation of a previous configuration of matter based on protons and neutrons; or a neutron star. Therefore, a black hole must encode in its properties all the previous information, such as: mass ratios such as the mass of planck in relation to the mass of the electron, etc. From the above it is derived that the radiation of a black hole or not is thermal (emission of particles increasingly massive as its mass is reduced) or its information is not lost, for example, due to soft photons and gravitons by conjecture of Hawking.

A strong indication that this information is emitted in its radiation is precisely the difference between 4π and $\log(196883)$; as we will show in a theoretical -heuristic way. Attending to these elementary premises, the following fundamental premises derived from the logic of string theory will be established: 1) In a black hole, time is stopped or ceases to exist as a dimension within the event horizon. This implies that the postulate of quantum mechanics is fulfilled that a particle can be both at different spatial sites, or at the same time in different states.

2) The holographic principle manifests itself as the information encoded on the surface of a sphere. According to the string theory that we adopt in this work; the quantity of dimensions is that of 26, the primitive theory of Bosonic strings that includes the graviton. If a black hole is purely gravitational; then its surface is formed by circular closed strings or gravitons. Likewise, the four dimensions must be encoded on its surface, as well as the twenty-six dimensions. Effectively the surface of a sphere is exactly the sum of the surface of four circles; this is: $4\pi \cdot r^2 = 4(\pi \cdot r^2)$

3) The reduction of the twenty-six dimensions to the eleven dimensions of the theory M, would be due to the dimensions expressed as the sum of the state of projections of all the possible spins (maximum spin of the graviton); this is: $26 - \sum_s 2s + 1 = 11$

4) The generating dimension of the monster group (196883), would actually be the number of mutually connected hyperspheres in twenty-six dimensions (grid in 26 dimensions).

5) The Heisenberg uncertainty principle is what allows the evaporation of a black hole. This means that the gravitons or circles are vibrating indeterminately. When a graviton leaves the surface emitting, for example, two photons; the circular hole left on the surface of the event horizon is closed by the attraction of the rest of the vibrating circles-gravitons of the surface of said horizon of the black hole.

This effect reduces both the mass and the surface of the black hole.

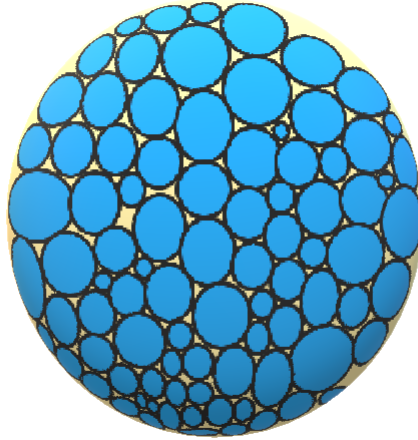
The uncertainty principle of Heisenberg must be extended, then, to d dimensions; according to the following known equation: $\frac{4 \cdot (2\pi)^{d-1}}{d^2}$

The proof of the existence of the seven dimensions rolled in circles (11d-4d); it is precisely the ratio of the mass of the Higgs boson to the mass of the electron;

as we have shown in our previous articles. And it is based on the Heisenberg uncertainty principle for 7 dimensions. This ratio is exactly (matrix of 7 Higgs bosons or seven dimensions): $\frac{m_h}{m_e} = 4(2\pi)^{7-1}$

In this paper, two types of equation results will be presented: a) Theoretical-heuristic equations. b) Empirical-heuristic equations whose probability of chance can be considered null.

Graphically the surface of the black hole by the hypothesis of closed strings or gravitons is shown in the following figure



1 Black Hole Emission Process

As we have already mentioned, closed strings or gravitons do not have a position determined by the uncertainty principle. Because of this it is possible for a graviton to escape from the event horizon and decay into other particles. In the low energy regime, the most logical and probable thing is that it decays into two photons and these, in turn, into an electron-positron pair.

Therefore, if we maintain the hypothesis that the emission of a black hole is not thermal; that is to say: when the temperature of the black hole increases, the gravitons can decay into other particles, such as two Z bosons. This process would continue throughout the entire evaporation time of the black hole.

2 Quantum Mechanical Calculation Of The Entropy Of a Black Hole And Confirmation Of E. Witten's Hypothesis

When the black hole has a huge mass, like those in the nuclei of galaxies, its emission energy is very small; so we expect emission of photons and electron-positron pairs.

2.1 Fraction of electron-positron pairs for a zero momentum electromagnetic fine structure constant; ie: for the vacuum.

Under these conditions and considering the Planck mass, the fraction of electrons or their entropy will be:

$$\ln(m_{PK}/m_e)$$

The previous equation must take into account the probability of emission or absorption of a photon by an electron for the zero momentum regime or the vacuum. This is for the fine structure constant for vacuum $\alpha(0) = 137,035999046^{-1}$

Therefore the first correction term that must be subtracted (the information is emitted) to the entropy given by 4π will be:

$$\ln(m_{PK}/m_e) \cdot \alpha(0)$$

This first correction gives us an entropy of:

$$4\pi - \ln(m_{PK}/m_e) \cdot \alpha(0) = 12.903537986745 \simeq \ln(196883) = 12.1903649226571$$

At a certain moment the temperature of the evaporating black hole will be high enough for a graviton to decay into two Z bosons, and these in turn into particle-antiparticle pairs of the standard model. For a minimum energy we can consider that the Z bosons decay into an electron-positron pair.

This reasoning leads us to a positive correction heuristic term given by the following equation:

$$\frac{2 \cdot m_e}{m_Z}$$

Considering this new correction, we have that the entropy acquires the following value:

$$4\pi - \ln(m_{PK}/m_e) \cdot \alpha(0) + \frac{2 \cdot m_e}{m_Z} = 12.1903650063152$$

As can be seen, the previous equation gives us a precision of five decimal places with respect to $\ln(196883)$

2.1.1 Empirical heuristic final term

Starting from the hypothesis that the entropy conjectured by E.Witten is given for the entire range of energies; then it is logical to suppose that perhaps a correction term could be due to the GUT theories, with the X and Y bosons. Being $\ln(m_X/m_Z) \simeq 33$

The empirical heuristic negative term found is given by the equation:

$$\frac{1}{2 \cdot \ln(m_X/m_Z) \cdot m_Z}$$

The final equation for entropy, adding this last correction gives the following result:

$$4\pi - \ln(m_{PK}/m_e) \cdot \alpha(0) + \frac{2 \cdot m_e}{m_Z} - \frac{1}{2 \cdot \ln(m_X/m_Z) \cdot m_Z} = 12.1903649214088$$

This gives us a precision of eight decimal places with respect to $\ln(196883)$

3 Conclusion

Applying simple reasoning from string theory and quantum mechanics, we consider E.Witen's conjecture about the entropy of black holes given by the value $\ln(196883)$ to be proven.

Remark 1. An Amazing Equation That Relates The Monster Group And The Mass Of The Electron

$$\frac{(196883)^{\ln\left(\frac{\alpha^{-1}(0)}{2}\right)}}{1 + \sqrt{\frac{m_e}{m_h}}} = \frac{m_{PK}}{m_e}$$

m_h = Higgs boson mass