The Relative Holographic Principle and Explanation of Gravity

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Abstract: Maxwell's Demon has been used to show that measurement has an energy cost. The price Maxwell's Demons must pay can be found by use of Landuauer's Limit at Hawking Temperature. The use of Hawking Temperature in the Landauer Limit will extract just the energy contained in a constrained degree of spin freedom for spin ½ particles.

The Landauer Limit describes the amount of energy required to erase one quantum bit of information, which is equivalent to the amount of energy originally constrained . The goal is to see if there is a relationship between the Landauer Limit at Hawking Temperature and the gravitational energy of a one Planck Area of a given black hole's event horizon. We will assume a 1km radius, non-rotating Schwarzschild Black Hole. This will require several steps outlined below.

Steps:

Calculate mass of 1KM black hole using Schwarzschild metric.
Calculate the total gravitational energy of that black hole in Joules.
Calculate the number of Planck Areas of a given black hole = N_p.
Divide total energy by the number of Planck Areas.
Record the answer.
Calculate the Hawking Temperature of the black hole.
Use the Hawking Temperature input into Landauer Limit formula report in Joules.
Record results and compare any factor of difference between Landauer and General Relativity.

Results were GR = 1.261×10^{-30} Joules per Planck area
Landauer at $T_H = 1.74 \times 10^{-30}$ Joules.

A factor of 0.724 indicates a connection between General Relativity's gravitational energy and the energy in a constrained degree of freedom of an entangled pair of spin ½ particles as an emission process.

Calculating black hole's gravitational energy:

Find the mass, M, of a black hole using Schwarzschild Metric-

$\frac{(1000m) \times (299{,}792{,}458\ m/s)^2}{2 \times 6.6743 \times 10^{-11}\ m^3\,kg^{-1}\,s^{-2}}$ M = $\frac{1000m \times 8.98755179 \times 10^{16}\ m^{2/}s^2}{1.33486 \times 10^{-10}\ m^3\,kg^{-1}\,s^{-2}}$ M = 6.735×10^{29} kg

Calculate Gravitational Energy E = $MC^{2:}$

E = $(6.735 \times 10^{29}kg) \times 299{,}792{,}458\ m/s^2$ = E = 6.0736×10^{46} Joules

Calculate energy per Planck area:

$\frac{6.0736 \times 10^{46}J}{4.813 \times 10^{76}}$ = 1.261×10^{-30} Joules

Calculate Hawking Temperature of 1km black hole:

$$T_H = \frac{\hbar C^3}{8\pi\, Gmk_B}$$

Constants:

Reduced Planck's Constant: $\hbar = h/2\pi = 1.054571817 \times 10^{-34}$ Joules

Planck's Constant: $h = 6.62607015 \times 10^{-34}$ Joules

Calculate Hawking Temperature T_H

$$\frac{(1.054571817 \times 10^{-34} \text{Joules}) \times (299{,}792{,}458\ m/s^2)}{8\pi \times 6.67430 \times 10^{-11}\ m^3\,kg^{-1}\,s^{-2} \times 6.735 \times 10^{29} kg \times 1.380649 \times 10^{-23}\ J/K}$$

$$T_H = N/DT_H = \frac{2.8477 \times 10^{-9} \text{ Joules } m^3/s^2}{1.5616 \times 10^{-2} \text{ Joules } m^3 / s^2 \text{ per K}} = T_H = 1.823 \times 10^{-7}\ K$$

Calculate Landauer Limit at Hawking Temperature

$E_{Landauer} = K_B T_H \ln(2) = (1.380649 \times 10^{-23} J/K) \times (10823 \times 10^{-7} K) \times 0.6931 = 1.74 \times 10^{-30}$ Joules

Comparison between Landauer Limit energy and General Relativity Gravitational energy:

Value from General Relativity = 1.261×10^{-30} Joules
Value from Landauer Limit at T_H = 1.74×10^{-30} Joules

A factor of 0.724 between GR and Landauer at T_H is quite close to RMS, a typical emission indicator. This extra energy beyond .707 could be associated with the emission's spin being encoded into the photon and possibly even the wormhole.

The Effects of curvature:

Curvature has a significant effect on the level of energy in a constrained degree of freedom. A black hole with a 100km radius will have two orders of magnitude greater radius than a 1km black hole and will possess a Landauer value that is two orders of magnitude lower.

100km Black Hole gravitational energy from GR = 1.261×10^{-32} Joules
and the Landauer Limit at Hawking Temperature = 1.71×10^{-32} Joules.

The relationship between spatial curvature, defined by radius, and the energy in constrained degrees of freedom, the Landauer Limit, is inversely proportional to a change in radius. The energy level of Landauer is not set by the amount of gravity, but instead by the spatial curvature of the local system. A black hole with a 6400km radius, the same radius as Earth, will have the same energy level expressed for the gravity at the surface of Earth as that black hole. Spatial curvature is the main driver of the cost Maxwell's Demon must pay to measure entangled pairs. This also indicates micro-black holes will emit high energy levels of Hawking

Radiation and high levels of gravity.

To find the energy by curvature we can now take the 1KM black hole value of 1.74 x 10^{-30} Joules and find the scale of curvature and adjust the Landauer Value without having to find Hawking Temperature or the per Planck Area gravitational energy of that black hole.

A 1km black hole's Landauer Limit can easily be scaled down to a black hole of 10^{-6} km. Landauer Limit for that smaller black hole can be expressed by-

$E_{Landauer}$ = 1.74 x 10^{-30} J x the scale factor of 10^{6} = 1.74 x 10^{-24} J.

For a black hole the size of the universe at 13.8BLY, the Landauer energy level can be scaled using the same process. The scale difference between 1KM and 13.8BLY is
1.31 x 10^{23} orders of magnitude.
Therefore we can take that scale factor of 1.31 x 10^{23} x 1.74 x 10^{-30} J of $E_{Landauer}$ of a 1KM black hole and find-

$E_{Landauer}$ = 2.279 x 10^{-53} J for a black hole the size of the universe.

We will use this value for the Holographic Relative Cosmic Horizon as the per Planck energy level is the same whether curvature is a positively shaped or negatively shaped object, the difference between the outer surface of a sphere gravitating inward and an inner surface of a sphere gravitating outward.

Reason for higher Landauer Limit energy levels at higher curvature, smaller radii:

In the case of high curvature from small radii, the energy levels needed to erase, or more aptly, clock a quantum state are “hiding” behind the curvature. For example, consider a slide projector projecting onto a flat screen and say you measure that value reflected off the screen from behind the projector. If you bow the projector screen towards the projector, you will see less apparent energy. In order to see the same apparent magnitude of energy, the slide projector bulb will need to have an increase in intensity to equal the value of energy that was measured from a flat screen. This explains why surfaces with low curvature require less energy to measure quantum states and why surfaces with high curvature, objects with small radii, require more energy.

Quantum Mechanical description for the emergence of gravity and Hawking radiation:

Gravity seems most easily explained come from considering entangled spin ½ particles because spin ½ particles have 720 degrees of spin information encoded into their structure. The two 360 degree rotations in a spin ½ particle are opposite and can be thought of upon measurement as an emergent spin and a counterfactual spin.

Assume we have an entangled pair to be measured, A and B, both with spins in superposition. We have particles A and B which are entangled on a system that has a 1km radius, say not a black hole this time, but a small compact asteroid that causes its own curvature via gravity. The entangled pair A and B are a system that has four bits of information, Up/Down, Down/Down, Up/Up, Down/Up, but two are prohibited because of conservation of angular momentum, Down/Down and Up/Up are disallowed. The particles are entangled so are required to exhibit opposite spins upon measurement.

When A's spin is measured, its counterfactual spin forms a wormhole as a statement of causal uncertainty because B is non-local. This wormhole then causes A and B to become local and so the uncertainty is resolved and the wormhole emission is complete. Spin is then encoded as nature's "data type" instead of gravity. A and B very briefly became local, so that B's spin is properly correlated. When B's spin is measured, B's counterfactual evolves to become a Hawking photon at Hawking Temp. The energy calculations are as follows:

A is measured requiring a minimum of 1.74×10^{-30} Joules to set its emergent spin state. Then A's counterfactual bit senses B is non-local so A's counterfactual evolves into a wormhole at 1.74×10^{-30} Joules for just long enough for A and B to become local, exchanging 1.74×10^{-30} Joules so A and B are correlated.

Then to complete the cycle B is measured and B's counterfactual bit turns into a Hawking photon at 1.74×10^{-30} Joules. If you take the Hawking photon and divide by Boltzmann's Constant, that photon becomes Hawking Temperature.

The energy expenditure in creating non-local correlations is real and is required for non-local effects to translate though spacetime. It's not merely a static correlation between particles, its work being done and work requires the expenditure of energy.

Bell's Inequality representation:

Bell's Inequality shows that there are no hidden variables that correlate non-local particle pairs, that quantum mechanics is non-local. Bell's treatment of the correlation says nothing about the energy required to translate spin correlations non-locally, so the added terms will capture the cost of facilitating non-local correlations.

Bell's interpretation: $-\cos(\theta A - \theta B)$. There is no explanation for how the four bits in the two particle entangled system are conserved. The following accounts for the energy expenditure. Consider the following-

E emission = E Counterfactual A + E Counterfactual B = E gravity + E photon.

Now we can add the terms to Bell's interpretation.

$E'(\theta A - \theta B) = -\cos(\theta A - \theta B) + f(\text{Counterfactual A} + \text{Counterfactual B})$

-where f(Counterfactual A + Counterfactual B) accounts for the cost associated with maintaining non-local correlations.

This is the payment for Bell's services. All of the measurement energy values are the same for each bit, in spite of each bit being a different "data type", in the case of a system with a radius of 1km, 1.74×10^{-30}J whether the data type is spin information, gravity information or photonic information. A given non-local correlation happens in a sequence. It;s important to note that the Landauer and gravity energy values are the same regardless of spatial separation in 3-D space with no change in energy level from an increase in distance between entangled particles.

Holographic Encoding Effect, a similarity to Juan Maldacena's AdS/CFT:

AdS and CFT explain the relationship of information to volume. Every 3-D region of space can be described by its 2-D boundary. Since the amount of energy in a constrained degree of freedom is based on curvature, something else must account for the 3-D distance between entangled particles appearing to being made local by wormhole and how the value of the entangled energies is not dependent or related to the amount of spatial separation between the particles. This is because the Holographic encoding of the Holographic Cosmic Horizon provides the structure necessary for instant correlations regardless of spatial separation.

The holographic surface can be thought of as a relativistic surface, but it only emerges relative to the observer at cosmic distance. From the perspective of an observer on the the Holographic horizon, which is impossible, but for the sake of argument, the horizon behaves much like a black hole's event horizon and that means maximum length contraction and time dilation. This means that the entire surface is under such severe time dilation and length contraction that it appears “locally” there as a singularity, and all information in the observable universe is encoded onto that singularity. We as observers in the center of the observable universe interpret that we are on the inside of a negatively curved black hole with 13.8 BLY radius. This relativistic effect at the horizon is what allows Holographic encoding, all particles are adjacent to all other particles.

Now we have the information to describe how non-local correlations happen in 3-D space. Since all particles are equally encoded on every portion of the holographic horizon this means all particles are adjacent to every other particle. Even if A and B are separated by billions of light years in 3-D space, their holographic elements will be adjacent to each other all across the surface of that horizon. Holographic elements of A and B can be found in every Planck Area of that horizon. So, even if A and B are separated by a billion light years, A and B are physically next to each other on the holographic horizon.

Performing a measurement of an entangled pair from the Holographic Horizon:

A and B are very close to each other on the holographic horizon, but are “spread” thinly. We will use the actual value of Landauer of the holographic surface which is equivalent to a universe sized black hole. This value will be projected from the Holographic cosmic horizon onto the 1km radius object.

When A' spin has been measured and say that value that emerges is Up at 2.279×10^{-53} J Landauer Limit. Then A's counterfactual spin evolves such that a holographic gravity bit enables A and B to be local by expending 2.279×10^{-53} J. A and B are very close to each other on the horizon and since they share the same wave function, A's counterfactual can find B and cause local spin correlation to ensure B's has a spin opposite of A's at an energy cost of 2.279×10^{-53} J.

Then when B's spin is measured, B's counterfactual emits a Hawking photon at 2.279×10^{-53} J. There is no more entanglement, there is no more causal uncertainty. This emerges in 3-D space by condensing by the scale factor between a 1km black hole and the Holographic Cosmic Horizon at 13.8 BLY is 1.31×10^{23} orders of magnitude.

Projecting that 2.279×10^{-53} J down 23 orders of magnitude causes gravity on the 1km object to emerge at 1.74×10^{-30}J. B's Hawking photon can be divided by Boltzmann's Constant to see the Hawking Temperature. The Hawking photons do not emerge randomly by some kind of probability of the event horizon emitting a photon, but instead emerge every entangled pair measurement as payment for measurement services. Furthermore, this means the black holes' Hawking Temperature energy is equivalent to its gravitational energy.

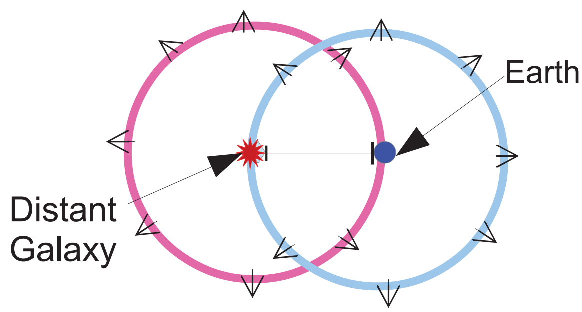
To calculate the projection we use the scale factor between 1km and 13.8BLY $= 1.31 \times 10^{23} \times E_{Landauer}$ at 13.8 BLY horizon 2.279×10^{-53} J $= 1.74 \times 10^{-30}$J at the 1km object in 3-D space.

The structure of the holographic cosmic event horizon allows instant correlations between entangled pairs no matter how distant. The energy of that large horizon is magnified by the scale difference and projected into 3-D space. This is how nature tracks the position of B, holographically, to restore certainty and provide local spin correlation between A and B.
The relationship between curvature and energy shows that curvature is intimately connected to the value of the energies contained in entangled degrees of freedom. On the holographic horizon there is no classical sense of distance between holographic elements, only a binary situation exists of local or non-local.

The first particle to be measured in an entangled pair will have its counterfactual bit become a wormhole as A's counterfactual encoded B's causal uncertainty. Locally this action appears like a wormhole, however this is not a classical wormhole with a gap. Only spin information can traverse the wormhole, but the wormhole's effects in 3-D space emerge as gravity. The holographic encoding of the cosmic horizon does not produce a wormhole as the gravity emerges in a holographic format to connect all holographic spin elements of A to the spin elements of B.

Nature uses a bit of negative energy to track causal uncertainty for the purposes of conservation of information. This will likely mean that Hawking photons are spin locked to reflect the spin state of the counterfactual bit that created it. Helicity or polarization is likely encoded as a reflection of the particle's spin to preserve information. Every Hawking photon is likely to have spin encoded from its counterfactual bit that produced it. Its 'also likely that the gravity bit, wormhole, has some form of spin as well to encode A's counterfactual spin information.

Connection to Dark Energy:
The relative holographic horizons are not only responsible for projecting our sense of reality and causing gravity, they also gravitate distant objects on a relative basis. This is the effect we attribute to “dark energy”. The inummerable relative holographic horizons are unique to each particle as they evolve through time. Together, these horizons cause distant objects to gravitate on a relative
basis.



A distant galaxy appears close to our holographic horizon and the gravity from that surface appears to gravitate that galaxy strongly out of our observable universe. But, locally that galaxy sees no giant event horizon surface. They notice that its in fact Earth who is being gravitated out of their universe by their holographic horizon. Even though locally both think nothing is out of the ordinary, the fact they both observers see the other observer being gravitated out of their relative observable universe is a consistent story. The total gravitation of that horizon must be equivalent to any amount of summed up “dark energy” to create that horizon. Its likely that no “dark energy” particles exist, that the emergence of dark energy is the summed up effects of relative holographic horizons gravitating, pulling distant objects on a relative basis. Gravitational energy is an expression of uncertainty and entropy. As objects cross that relative horizon, the casual uncertainty is encoded as gravity, a gravity bit for every out of causal contact QM information bit. That causes the horizon to grow in size and dark energy to go down in strength.

Changes in Dark Energy l evels have no affect on local gravity:

The way the projections are amplified by scale as seen above, means that more dark energy must mean a closer holographic event horizon, and fewer Planck Areas. For example consider a holographic cosmic event horizon of only 100km radius. We know from earlier that the Landauer Limit at Hawking Temperature on a 100km radius black hole is 1.74×10^{-32}J. This close of a holographic horizon would have very intense dark energy level, with objects only 90km away being gravitated at a relativistic pace. However, since the radius scale factor between the new 100km holographic cosmic horizon and the 1km black hole is only two orders of magnitude, the Landauer Limit of 1.74×10^{-32}J will only project two orders of magnitude higher energy, such that the Landauer Limit at the 1km black hole is still-
1.74×10^{-30}J.

Dark energy does not affect local gravity, but does affect how energetically distant objects are gravitated out of our observable universe, and how fast we gravitate out of theirs.

Gravity as a statement of uncertainty:

Gravity is used to encode uncertainty during entanglement measurements and also when objects cross relative cosmic holographic horizons and are out-of-causal-contact. In the case of entanglement, uncertainty is used to not only account for non-locality of B, but also used to restore certainty by making A and B local. On the holographic cosmic horizon, objects that leave the observable universe have their information encoded as gravity which adds additional bits to the event horizon, causing the event horizon to grow by the same number of Planck areas as the number of particle information bits that crossed the horizon. This reduces the effect of dark energy, but does not affect local gravity.

Nature uses a bit of negative energy to encode each case of out-of-causal-contact information as a form of energy conservation and information conservation. Its the same process emerging at different scales. When and if the uncertainty is resolved then the gravity bit is encoded as quantum information, for example spin, and the gravity emission terminates. Causal uncertainty is crucial to the existence of structure in spacetime.

Conclusion:

General Relativity is adept at explaining gravity profiles in large natural systems. General relativity is a normalized interpretation of a dynamic granular system of entanglement interaction causing individual units of gravity and Hawking radiation. Similar to how pressure and temperature emerge as a statistical representation of many particles interacting at speed and density, General Relativity measures large scale gravitational pressure without accounting for the individual particle interactions. General Relativity does not account for quantum measurement energies or causal uncertainty. Naturally, if we add energy into a system the speed of entanglement making-and-breaking will increase and that will increase gravity, but its not a direct relationship. Gravity emerges as a function of entanglement frequency and density of emission. Nature uses enormous kinetic energies to extract very little gravitational energy. By using entangled photons to entangle spins, it will be possible to use low energy photons at high frequency to make and break entangled pairs at density. If the photons used to entangle spin ½ particles are just above the energy cost to Maxwell's Demon, then the efficiency of creating space time curvature will be much more reasonable, making gravity technology feasible and achievable.

Gravity emerges on Earth using this same process. The surface of the Earth has a curvature of about 6400km, and so has a measurement cost of 10^{-34}J and emits at that rate. The Hawking radiation should be at .7Hz at the surface. If you measure gravity closer to the core, then the curvature will cause higher measurement energies, up to 10^{-23} J for a gravity bit at the core, the area where the core would become an event horizon if Earth was collapsed into a black hole. In near Earth space where the spatial curvature is less than the surface, the value of measurement energy goes down by an amount related to its increase in radius. This concept can be used to better understand gravity, dark energy and inflation. Inflation was an era when the relative holographic horizons were very small and dark energy very high, and as objects crossed the relative horizons, the relative horizons grew very quickly and dark energy values went down.

In this interpretation, photons do not gravitate. Photons do not have the necessary degrees of freedom of information and don't have to obey Pauli's Exclusion principle so cannot directly cause gravity. Even during pair production, photons produce antimatter to conserve information, so that no new particles are created by annihilation and so turn back into photons. Photons only assume particle like existence in extreme conditions and revert back to their photon like existence usually very quickly. Photons are naturally non-local objects so they don't require work to entangle, but spin ½ particles are much more localized.

In this interpretation, black holes do not have interiors. The densest region that can exist is only a 2-D sheet at a maximum density of one quantum bit per Planck Area. The singularity is relative to the infalling observer as the event horizon shrinks due to relativistic effects, the horizon gets smaller and smaller until it effectively appears to the infalling observer as a singularity. The Holographic Principle ensures no region of space can have a greater density than a 2-D surface one bit of information per Planck Area. The region just beyond the event horizon would be too dense to exist.

The way the Landauer Limit at Hawking Temperature correlates to General Relativity's gravity at all scales is unlikely to be a statistical anomaly. The connection between the energy cost of non-local communication between entangled particles and gravity is too convenient to ignore. The way the quantum mechanical description above deals with black hole entropy is simple, it encodes the counterfactual spin into the photon and information is conserved. It may encode spin into the gravity bit as well. It appears that nature is telling us conservation of energy and information apply even at the smallest of scales and that every little bit of information is important and tracked by the universe.

There could be a .7Hz signal in the noise in LIGO detector that would be there all the time and may be detectable by Fast Fourier Transform of low frequency analysis of less than 10Hz. This correlates to an approximately 10^{-34}J energy level.

Acknowledgments:

I began this journey only to answer a question from my friend Alex who asked me “what can be done with the energy in a constrained degree of freedom?” I felt I owed him a clear explanation. As I approached this path, it became apparent that the answer is complicated, yet it provides a simple for an explanation of gravity. And in two months I had Alex's answer prepared as best as I could explain. I find small things fascinating, and may have found that the most innocuous of energies, often overlooked, could actually prove to be significant.

I recognize this paper was built on the shoulders of giants, Maldacena, Susskind, Boltzmann, Planck, Einstein, and many others who laid the foundation for these interpretations. I felt this interpretation offers simple explanations for complex phenomena and wanted to share it in case it helps takes one tiny step to greater understanding of the universe.

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