Xyston Equality in three dimensions

Gelanor Rhadamantys

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Abstract

In this paper we build on the intuition of the Xyston Argument [5], converting it into a three dimensional analogue and expand it to cover spherical light sources at arbitrary distances.

Introduction

Ever since Max Planck solved the Ultraviolet catastrophe by quantization of the problem of black body radiation, Quantum Mechanics has improved as the application of the quantization pattern [5] to new and more specific sub-problems. This has been used to generate new predictions from the quantized model. In those cases where the experimental data bear out the predictions this has improved our understanding of the universe. For the past 100 years, the dominant interpretation of Quantum mechanics has been the Copenhagen interpretation [4]. This view essentially claims that Quantum Mechanics is complete. This was contested by Einstein and others, claiming that what we now refer to as Quantum Entanglement required faster than light communication, and therefore contradicting itself. Therefore quantum mechanics could be argued to be incomplete. This viewpoint has been developed by many others, and suggest that there is a deeper level than quantum mechanics, whose interactions results in statistical laws we now know as quantum mechanics.

However, the the Copenhagen interpretation was able to enlist the support of the Bell Inequality [3], ostensibly proving that the Einstein-Podolsky-Rosen paradox [2] and other assertions that Quantum Mechanics are incomplete imply problematic behaviour. Specifically, the Bell inequality asserts that a local hidden variable theory cannot be compatible with quantum entanglement without faster than light communication, which would make it incompatible with other foundation features of quantum mechanics. As a device, Bell introduces a duality between local and non-local theories, where the former allow information to propagate at the speed of light and the latter allowing instantaneous communications. Quantum entanglement appear to exhibit faster than light communication, and therefore any hidden variable theory must be non-local. However, non-local theories are unpalatable due to how they disregard established laws of causality, violate numerous mathematical theorems and generally seem contrived.

It is a growing view, that this interpretation of Bells inequality is incorrect. While the mathematics of Bells inequality is sound, it is not true that hidden variable theories must be non-local, but that it puts contraints on the type of locality. If we imagine a local, hidden variable theory, completely deterministic, it is possible to realize quantum entanglement simply by having a shared past, which synchronized the particles in their internal clock-movements. This however, does not explain the indeterminancy.

In 2019 Sean Carroll published the book "Something Deeply hidden". [1]. In this book, Carrol explains how the many-worlds interpretation is able to explain quantum entanglement in a different way. In the book, he shows how the idea of simultaneous realities provide a different intuition informing the nature of quantum indeterminacy and entanglement. This is important when taken together with the fact that the Bell inequalities does not apply to Many Worlds interpretations. It is a common misconception that the Bell Inequalities require any hidden variable theory to be non-local, or break the speed of light. Rather, the Bell inequality identifies a phenomenon of quantum mechanics which appears to feature faster than light communication. It simply states that any theory must be able to account for both the indeterminacy, entanglement and avoid breaking the speed of light at the same time. If it cannot, it cannot be a more accurate theory.

The Xyston Equality

In the previous paper The Xyston Argument [5] we present a new heuristic for meeting these requirements. It builds on an important realization, that under many worlds interpretation, hidden variable theories are not restricted by the Bell Inequality. In short, entanglement is explained as a function of computational determinism, quantum indeterminacy (and the results of the double slit experiment) are direct results of observer effects. Speed of light is explained as nearest neighbour propagation of information. The Xyston argument allows us to study a class of local hidden variable theories that are defined in a fully quantized spacetime, with particular emphasis on what these theories cannot possibly be able to do.

In the first paper "The Xyston Argument" [5], we connect the very small to the very large by claiming that in any completely quantized theory of unification, even the direction of travel for photons must be constrained to a quantized option space. This means that there will be constraints on the available paths that light can travel. Essentially, the Xyston Argument is : If everything is quantized, the options space for the direction of light must also be quantized. What would be the artfacts of this directional quantization? Can it be indirectly observed?

The Xyston Argument predicts behaviour of light that is starkly different from what we would normally expect. It also showed that separating a stochastic process producing directionally quantized light from continuous, wave-like is difficult unless the detector is very small so that the resulting dark-zone occulting effect can be directly observed. In this paper we take intermediate steps in narrowing down how to detect artefacts of the quantization of the directional option space.

The Simple Xyston Equality

Let an emitter emit e photons randomly into a quadrant of a circle. Let L be the length of an arc segment, d the radius , and e the amount of emitted photons. The received flux T_c equals the size of the arc segment divided by the arc length, multiplied by the emitted photons. This is called the Simple Classical Flux equation.

$$\tau_c = \frac{L}{2d\pi} e \tag{1}$$

In the Xyston Argument [5], we introduce the Simple Xyston Process. We construct a stochastic process which emits photons that propagate across a two dimensional grid structure. In this grid we place a detector, and the flux that this detector receives τ_X, equals the emitted photons, divided by the number of possible directions that light can travel (lightlanes), multiplied with the expected number of lightlanes the detector intersect. This is expressed through the Simple Xyston Process equation, where the first term is the number of lanes that the detector will intersect, and the second term is the number of Photons emitted through each lightlane.

$$\tau_x = \frac{L}{\frac{2\pi d}{2^b}} \times \frac{E}{2^b} \tag{2}$$

The equation can be understood as a scalar (first term) and a bag of photons (second term). The scalar represents how many bags of photons to expect on average. The size of a bag of photons remain the same for each value of b, only the first term changes as we modify the distance and size of the detector.

$$\tau_x = \frac{2^b L}{2\pi d} \times \frac{E}{2^b} = \frac{2^b LE}{2^b 2\pi d} = \frac{L}{2\pi d} E \tag{3}$$

However, if we try to shorten the Xyston Process equation using normal rules of calculus something interesting happens. Xyston Equation process and the Classical Process equations are the same as long as first term of 2 is treated as a probability. That is only possible under the assumption that there are many simulations with different detector positions that are going to be averaged. It is therefore worthwhile to keep both forms of the equation, as they represent a slightly different things. However, they remain the same for all but the most precise measurements. If this is the case, the equations we use to predict flux remain agnostic as to the underlying stochastic process for light emission and propagation. The Xyston Process is as accurate as the classical wave-nature of light in estimating flux. This high degree of accuracy also explain how this can have been hidden from view, because our expectation that light can go in any direction is caused by the convenient fact that the average form of the Xyston Process equals the classical, infinite freedom of direction both expressed in equation 1.

However, the first and second term of the Xyston Process equation (2) might possibly interact in ways that create higher flux variation in individual emitter and detector setups than a classical model with infinite directional freedom, as explained in [5]. In this paper we build on this approach, converting the Xyston Equation into a three dimensional analogue, and extending it to cover spherical light sources.

3D analogue of Xyston process

The Xyston Equality showed the equality between an information based approach and a classical approach. We will now convert this relationship to 3D.

In a three dimensional analogue of the Xyston process, we will develop equation for both point emitters and spherical emitters of arbitrary size. These will be marked x and X respectively, annotated with A for area and L for length. The light source is a point emitting in all possible directions around it. The area of the space between four light lanes are given by the sphere surface area $4\pi d$, divided by the number of lanes 2^b,

$$A_x = \frac{4\pi d}{2^b} \tag{4}$$

and to get the grid side length we take the square root

$$L_x = \sqrt{\frac{4\pi d^2}{2^b}} \tag{5}$$

From point to body emitter

For body emitters, we can think of them as a finite range of point emitters placed side by side, each taking up exactly one Reduced Planck Length L_P The grids projected from each point emitter in this range will overlap, creating a finer grid. As the size of the grid increases, this continues until the dark zone between lanes are larger than the emitter itself, see figure (1) and (2). Therefore, the difference between a point and a spherical emitter is only a scalar that subdivides a grid cell from a point emitter into as many parts as there are point emitters along the diameter of the radiant source.

Hence, the formula for the distance between grid points is given by the point emitter width subdivided by the number of adjacent point-emitters.

$$L_X = \frac{\sqrt{\frac{4\pi d^2}{2^b}}}{2r_e} \tag{6}$$

For area however, the subdivision will occur both on the X and Y axis of the projected grid. The grid area is reduced by the square of the emitter width, measured in Planck Lengths.

$$A_X = \frac{\frac{4\pi d^2}{2^b}}{4r_e^2} \tag{7}$$

Using this equation, we can calculate the Xyston grid size and area from any light source, as long as we specify the metrics in Planck units.

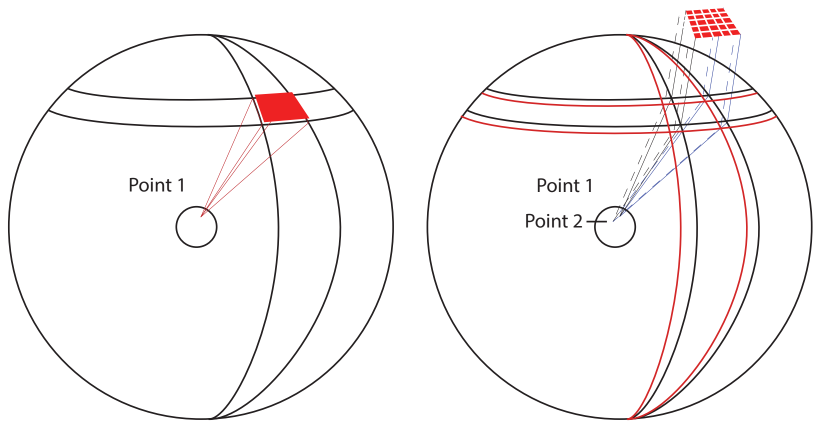

Figure 1: The grid resulting from a low resolution point emitter. Additional point-emitters subdivide the grid, producing a finer grid

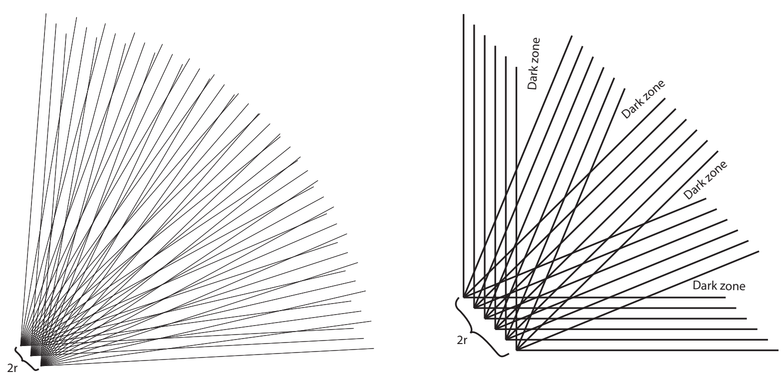

Figure 2: Body emitters are point emitters which overlap until they reach the dark-zone wedge

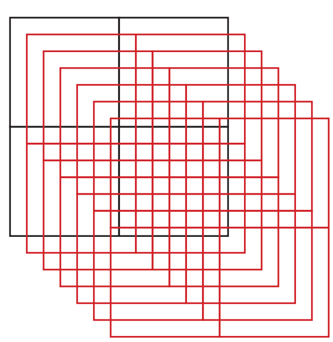

Figure 3: Subdivided grid projection. Grid result of spherical emitter, simulated through overlaying point emitters.

Xyston cycles

We can use equation 7 to calculate the flux. However it's important to develop our understanding of what happens when lightlanes intesect with a detector. We start with the simplest case, using a circular detector, chosen because it is invariant over the grid orientation.

In this particular case the detector diameter equals the diagonal of the grid so that ($2r = \sqrt{2}L_x$). What are the minimum and maximum number of lanes that this detector can intersect with?

In Figure 5, we can see that when $2r = \sqrt{2}L$ all corners of the square touches the circle when the circle is perfectly centered inside the square. If we move the grid or detector around, it will intersect with two corners, or one corner. The special case of intersecting with 4 corners is only possible as an edge case, and has 0% probability. Notably, the value for grid size $2r = \sqrt{2}L$ was chosen because it represents a transition value. If we reduce the grid size (increase resolution) so that $\sqrt{2}L < 2r$, then the probability of intersecting 4 lanes starts to grow from 0. However, if we increase the grid size (decrease resolution) we will see that the probability of encountering only one corner grows, while the probability of intersecting two corners falls. Eventually as we reach the lowest threshold value of all$0 < 2r < L$, we enter into the "Occulting" cycle 0,1 shown in figure 4.

This demonstrates that there are distinct transition values, where values for the grid and the size of the detector transition from cycling between 1 and 2 lightlanes, and begin cycling between 0 and 1 lightlanes. Such transition points exist for each integer. The measured flux is smoothed between transition points by the amount of time that the detector spends intersecting the high number of lightlanes versus the low number of lightlanes in its current cycle. I.e : Let the detector have a size so that it intersect 2 lanes 30% of the time, and 1 lane 70% of the time. The detector will be in the $1, 2$ the flux will be $0.3E_L + 0.7E_L$, where E_L s the number of photons per lane, per unit of time.

Consequently, when a detector is positioned so that it can receive incoming flux, the amount of flux depends not only on the size and distance between detector, but also on the lightlane cycle. As the grid size grows, the probability that the detector will intersect the high number of lanes in each cycle drops gradually, and consequently the percentage of time receiving two lightlanes drops accordingly.

the time it spends receiving the high and low lightlane number in each cycle. This is approximated by the first part of the equation 8. However, holding total Emitted photons E constant, there must be a higher concentration of photons in each lightlane per unit time, if there are fewer lightlanes. We remember that the resolution of the grid, and therefore the number of available lightlanes for the E photons to be distributed among, depend on the bitength b through the denominator 2^b.

$$\tau_x = \frac{4\pi d^2}{2^b} \times \frac{E}{2^b} \tag{8}$$

0.1 Cycles

Patterns of information states are encoded by the means of binary logic (duality), which is predicated only on an abstract substrate, such as a grid or a network. Time can be seen as the relationship between information states on this grid, which may be direction agnostic. But if the evolution leads to an increase in entropy, there is an overall direction of time allowing for the definition of an arrow of time. The remaining complexity of our reality can be seen as emergent phenomena from this information undergoing evolution, selection and interaction. This begs the question, why does a reformulation under such minimalist assumptions work?

There are two possible answers:

1. The reformulation was possible due to the inherent flexibility on how to formalize any self-consistent algebra. Under this interpretation, a grid is a sufficiently flexible system to implement any algebra, and the fact that it works on Quantum Mechanics does not necessarily imply anything about the true nature of our universe.

2. The phenomena of quantization observed in quantum mechanics, and by extension in the real world, is inherited from a reality where spacetime is quantized. Such a reality would conforms to the DERP

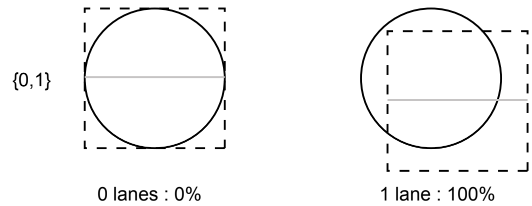

Figure 4: 0-1 "Occulting" cycle between $0 < 2r < \frac{L}{2}$. Alternates between 0 and 1 lightlane.

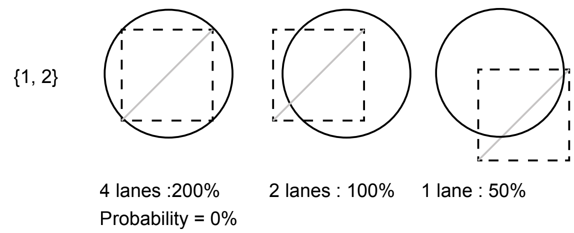

Figure 5: 1-2 cycle. Between $L < 2r < \sqrt{2}L$. Alternates between 1 and 2 lightlanes.

axiomatic foundation. This has the potential for intuitively explaining why quantization occurs and take so many forms.

It's obvious that discerning between these two possible answers would provide us with deep insights either way. But if the second answer is true, the consequences would far exceed the obvious - to elevate the Loop Quantum Gravity formulation of Quantum Mechanics to canonical status. It would reach much deeper, and open up opportunities to probing quantum mechanics at a deeper level than particle physics, through an entirely new field studying the foundational interactions that give rise to the forces of the universe. In this paper we intend to make a the first foray into this world of DERP Quantum Theory.

0.2 Cellular automata as a working model

Cellular automata such as Conways Game of Life can be used to imagine the problem information systems.

0.3 The pesky problem of free directional movement

Imagine a photon being emitted from a sun, far away. We have learned that the photon is both a wave (before being observed) and a particle (when observed) , and travels as a wave through something which we don't understand, but know how to work with abstractly as the electromagnetic field. Experiments such as the double slit experiment show that the act of observation, fixes the photon to a specific location, but other than that it moves as a wave.

When trying to implement this model of light as a Process of Information Evolution (PIE), we run into some thorny issues to explain:

1. The wave / particle duality
2. Superposition
3. Entanglement
4. Speed of light

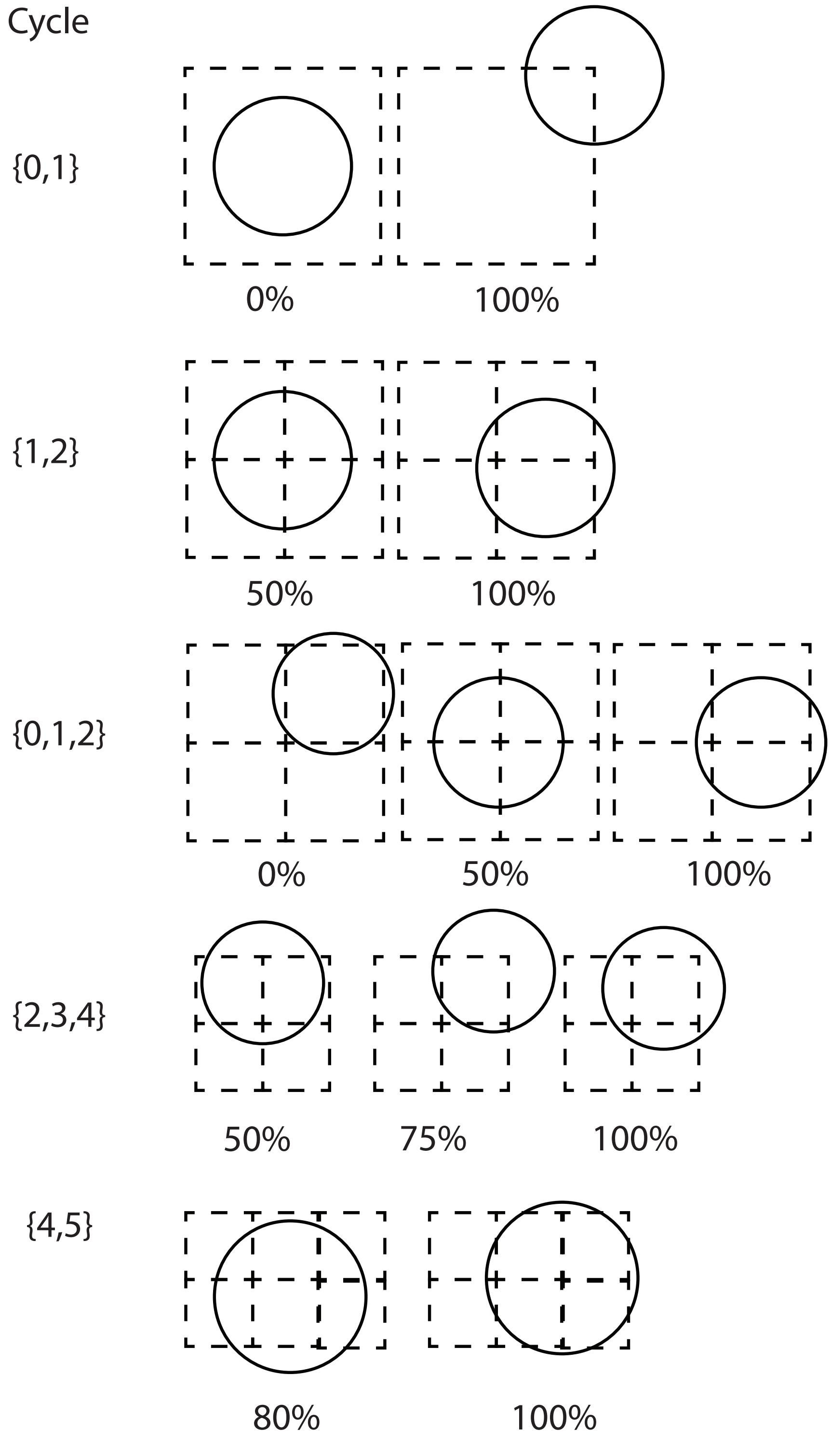

Figure 6: Cycles from 0 to 4. Notice that triad cycles are possible but for very constrained sizes of grid.

This paper will not go into details about the first three, this must be done for the purposes of brevity. Suffice to say that each of these can be understood in the context of a general theory of mind. The fourth relates to the photon travelling at the speed of light, when in a vacuum.

The expected photon count for a detector of radius d, placed at a distance d from an Emitter, when the Emitter emits only into one quadrant.

$$\tau_c = \frac{2r}{d\pi}E$$

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