On the Unification of Quantum Mechanics and Relativity, using the Computed Reality Interpretation

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Abstract

This paper builds on a few disparate existing ideas of Quantum Mechanics, and condenses them into one cohesive new interpretation named the “Computed Reality Interpretation”. This interpretation is demonstrated below to have a far stronger explanatory power in multiple respects, when compared to other interpretations such as “Many Worlds” or “Bohmian Mechanics”. The Computed Reality Interpretation is fully compatible with the popular “Copenhagen” interpretation, affirming the fundamental ability of particles to exist as pure equations.

In addition to its explanatory power for key Quantum Mechanical phenomena, this paper also shows how the Computed Reality Interpretation provides a natural explanation for key relativistic phenomena, namely time dilation and gravity. Multiple testable predictions are also described, in the areas of space-time topography, quantum gravity and faster-than-light travel.

The provided interpretation will thus be demonstrated not only to stand on its own as a powerful, experimentally testable, quantum interpretation, but also to serve as an umbrella interpretation under which Quantum Mechanical and Relativistic physical processes can both be naturally and logically explained within a shared context.

Overview of The Computed Reality Interpretation

The Computed Reality Interpretation posits that our reality is “computed”, i.e. manifested by a computing machine of some sort. Many people today are familiar with these types of realities, experiencing them as computer game worlds (Minecraft being a good example), virtual realities, augmented realities (such as Pokemon Go), physics simulations, and so on.

The interpretation condenses from a number of sources, most significantly the “Simulation Hypothesis”, which proposes that our reality is “simulated”, and on which Nick Bostrom made a significant contribution from a philosophical perspective in 2003.[1] In some ways this paper builds on that one, as it addresses a similar question, only from a more empirical perspective.

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[1] Bostrom, Nick (2003)

Principles

A number of principles of the Computed Reality Interpretation can be discerned. These are based on what we know to be true about computed realities which we ourselves create today, and so serve as a solid basis for the given interpretation:

- *Principle of Performance Efficiency:*
  Every computer program we create today has to pay attention to performance efficiency. A simple example is a program to print out the message “Hello Universe” onto a computer screen 1 million times. The programmer must be efficient with performance, perhaps adding a small wait between each print action, because otherwise the computer might become overloaded, and all other processes on the computer might grind to a halt, making the computer unusable for hours.
  Thus:

  > *The Reality Generator Software Program is generally designed to be efficient in terms of information processing. In some areas, ‘shortcuts’ are implemented, which increase performance efficiency at the cost of minor perceived discontinuities in otherwise consistent manifested behaviours.*

- *Principle of Code Neatness:*
  Every large computer program we create today has to pay attention to code neatness. This is important during the initial development of the system, and critical later on for maintenance, particularly when a person who did not originally develop the code wishes to make an update to the code.
  Thus:

  > *The code governing the operation of the Reality Generator Software Program is usually neat. However, where more important concerns have arisen (e.g. performance efficiency), the code is messier than usual.*

- *Other Principles:*
  Other well known principles of computing include: *Artefacts, Bugs, Glitches, and Requirements*. However since their manifested effects are more nebulous than the above two, we will not lean on them in this paper, and (given journal word limits) will not detail them here.

Explanatory Power

Quantum Mechanics

Overview

The idea of a Computed Reality has already been identified in the literature as an interpretation of Quantum Mechanics.[2]
In the 2017 paper by Tom Campbell et al., an analogy is drawn between Quantum Mechanics and a computer game, the former having the collapse of the wave function, and the latter having the mechanism of only rendering a particular object when a player looks towards the object.[3]
In a paper by Silas Beane et al, attention is drawn to a parsimoniousness towards information which seems to be a hallmark of computed realities generally, and is shown to be apparent in Quantum Mechanics.[4]

Entanglement

First, let us be clear that the phenomenon of Entanglement is real - not only has it been predicted in quantum theory, but it has been empirically confirmed many times.[5,6,7]. Let us not hold out much hope at this point that Entanglement is somehow a mistake in the calculations or measurements.
Rather let us accept that (barring something wacky like Superdeterminism) particles really seem to influence each other instantly at a distance, with no known particle which could conceivably serve as a signal by covering the required distance instantly.
The Computed Reality Interpretation stands above most quantum interpretations on this topic, because it naturally and logically explains how locality can be violated in this way. First it asserts that reality is not fundamental for the computed reality. Then, in accord with Copenhagen, these particles can simply share the same wave function, with the Reality Generator Software Program being responsible for processing that function. Thus it is a trivial thing for the program to update the single function, instantly affecting both particles regardless of their location within the Computed Reality.

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[2] Klee Irwin et al. (2020)
[3] Campbell, Tom et al. (2017)
[4] Silas R Beane et al. (2012)
[5] Yin, Juan et al. (2013)
[6] Matson, John (2012)
[7] Francis, Matthew (2012)

Wave Function Collapse

First, let us note that, in accord with Copenhagen, the Computed Reality Interpretation has no problem whatsoever with the idea of particles sometimes being represented purely by mathematical functions, and not in fact physically existing in our reality.

This in itself is a powerful insight, because it explains in a simple and fundamental way what the wave function might be, without having to develop a whole new set of formulas (Bohmian Mechanics Interpretation), and does so by proposing only 1 extra reality to solve the mystery, as opposed to near-limitless extra realities (Many Worlds interpretation).

As to why particles decohere in this way, this likely relates to performance, as per the *Principle of Programming Efficiency.* A close analogy is found in nearly all modern computer "shooter" games, where very fast and small particles (such as bullets), do not, as they travel, come to occupy all available game-reality spaces along the length of their vectors. Rather, these particles proceed in discontinuous "jumps". Collision checks with large objects are done using the a-priori method of comparing the particle trajectory with the 'hitbox' of the objects.[8]

Relativity

Time Dilation

Time dilation at high relative speeds is a phenomenon which has been experimentally verified to a high degree of confidence (indeed our modern GPS system would not work properly without accounting for it). However the Special Theory of Relativity does not say "why" it occurs, rather it just effectively crunches the numbers and the phenomena pops out.

The Computed Reality Theory offers a more fundamental explanation of "why" time dilation occurs. And it is that time dilation is a performance improvement utilized by the Reality Generator Software Program.

Consider the example of 1 high energy particle moving at relativistic speeds - By supposing that this movement is being processed by a Reality Generator Software Program, then the system is likely working hard to check for collisions between this one particle and others. (and working much harder than it would be if the particle was at rest). Now consider what would happen if that particle decayed into multiple smaller particles. Well…. then the System would have to process collision scans for not just 1, but many fast moving particles, leading to an increased performance load.

Thus, the existence of any 'slowing down' mechanism, is not only generally indicative of a computing performance improvement, but we have also identified one specific process by which a performance benefit can be achieved by time dilation.

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[8] "Collision Detection" (Wikipedia)

Gravity

The General Theory of Relativity tells us that mass/energy tells spacetime how to bend, and the bending of spacetime tells that mass/energy how to move. But similar to how Special Relativity does not tell us “why” time dilation occurs, General Relativity does not tell us “why” gravity occurs.
The Computed Reality Interpretation offers a fundamental explanation for gravity. It is that gravity is a performance improvement utilized by the Reality Generator Software Program.
Consider the example of 1 million highly dispersed particles moving in space - By supposing that these particles are being processed by a Reality Generator System, there won’t be many collisions to process, and the performance load on the system will be light.
Now consider what would happen if all those particles are brought very close together. Now clearly there will be more collisions to process, resulting in a higher performance load on the System. In this context, it makes sense as a performance improvement to dilate time for particles which are grouped together in large masses. This would reduce the number of particle collisions (and probably collision “scans” also) which need to be processed in any given period of time, thus improving overall system performance.

Cosmology

Beginning of our Reality

It has long been a debate in both philosophy and science, as to “why” our reality exists (rather than the equally plausible scenario of it not existing at all). The Computed Reality Interpretation demonstrates a simple, and fundamental, science based explanation on this topic, because it affirms that we exist because at some point the computer system which manifests our reality was “turned on”.

Big Bang

As the overwhelming evidence for the “Big Bang” shows, our universe had a definite beginning, starting as a very small region of space containing simple particles, and expanding out to what we see today.
The Computed Reality Interpretation fits fully with our observations on this topic, because the best method we have today for generating expansive computed realities, is the algorithm of “procedural generation”. In this algorithm, a computed reality is not “designed” (by placing down mountains, rivers, planets, stars, galaxies etc. in specific locations), but rather “generated”, first by specifying the allowed building blocks, and then by specifying the rules by which these blocks can be placed. The reality-generation software then automatically builds the reality.
A good example of this technique is found in the Minecraft computer game, where the use of procedural generation not only results in reasonably believable (although grainy) terrain features, but also a reality of near-unlimited space, far outstripping the space available in computer games which use deliberately designed terrain
An analogue of this algorithm can be clearly identified in the Big Bang in our own Reality, where the “building blocks” are simple rudimentary particles, and the procedural generation of the reality is done by the laws of physics.

Physical Limits

In our reality, we encounter “physical limits”, such as the universal speed limit (c), which we cannot exceed, and the 1st law of Thermodynamics, which tells us we cannot create or destroy energy.
This need not have been the case. We could have been born into a reality where there was no fundamental speed limit, or a reality where we could by some esoteric process create more energy. But this is not what we empirically see. We see limits as to how fast we can go and how much work we can do.
The Computed Reality Interpretation explains this situation simply and reasonably, in that, since the Reality Generator Computer is posited to be large, but still not unlimited, then there MUST be limits placed on what can be allowed to occur within the computed reality, otherwise the Computer would eventually become overloaded with trying to handle the ever-increasing workload, and the system would crash

Permanence of Physical Laws

Something rarely, but occasionally, considered is the question of why our physical laws are unchanging. Why for example, the speed of light does not seem to vary from day to day, and why macro-objects keep their shape and do not occasionally change proportions inexplicably.
The Computed Reality Interpretation explains the situation simply and reasonably - because, regardless on whether a computer programmer themself lived in such a reality, when they set about developing a Reality Generator Software Program, then according to the *Principle of Code Neatness* and the *Principle of Performance Efficiency*, it would be simpler to code and also result in a more stable program, to omit these weird intermittent effects from the computed reality.

Beauty of Physical Laws

It has long been pondered why the physical laws we discover are often “beautiful” and/or ”neat”, such as the famous $e=mc^2$.
This need not have been the case. It could have been that $e=(mc*43*35+21/19)^2$.
The Computed Reality Interpretation explains the situation simply and reasonably - because according to the *Principle of Code Neatness*, we would EXPECT the physical equations which govern our reality to be generally neat in form.

What the Computed Reality Interpretation is NOT

We must be careful to address some common misconceptions about the Computed Reality Interpretation:

1. The Computed Reality Interpretation is not an “Anything Can Happen” explanation, in the sense of a lazy interpretation which can fit any arbitrary set of data. Examples:
    - I have taken care to identify explanatory power over physical phenomena, only where the provided interpretation can most clearly be applied. Thus for example I make no claims for the interpretation in relation to the mysteries of Dark Matter, Dark Energy, Inflation, why time and space are Relative for different frames of reference, the nature of the reality where the Reality Generator System operates, or the intended purpose of the system.
    - The provided interpretation comes with principles which guide us along specific paths of investigation. For example, it strongly points us away from proposed solutions which are not performant (e.g. the Many Worlds Interpretation), away from proposed solutions which are “messy” in terms of their physical rules, and away from theories of “Deliberate Design” of our reality, with theories of “Procedural Generation” being much more strongly favoured.

2. The Computed Reality Interpretation is falsifiable, and is not “inevitable”. Examples:
    - If locality always held, with no entanglement, the explanation would not fit,
    - If particles were always real, & never in waveform, the explanation would not fit.
    - If our universe were eternal, the interpretation would not fit.
    - If there were no hard movement limits like c, the interpretation would not fit.
    - If physical laws changed intermittently, the interpretation would not fit.
    - If physical laws were generally “ugly”, the interpretation would not fit.
    - If something like String Theory manages in future to explain all the phenomena discussed above, in a similarly natural way but without requiring an extra reality, then the interpretation would not fit.

Testable Predictions

1. According to our best description of space-time (General Relativity), our universe is a continuous “topography”. An efficient way to represent this computationally, is to use a fixed computational “array”, specifically a 3 or 4 dimensional array, in which space-time is quantized into a grid of discrete “cells”.
   One characteristic of this, is that the grid would necessarily be cubic, rather than spherical. This may have an empirically noticeable effect at the boundaries of the grid, because, unlike the “sides”, where galaxies would necessarily be prevented from drifting/moving over the edge in one piece, there may be no necessity to prevent drift toward the corners, and because it is not necessary, the *Principle of Code Neatness* indicates that such a limitation may not exist.
   The key testable prediction here is that the universe may have 8 “corners”, in which galaxies would appear to have drifted further away from us than galaxies at the “sides”.

2. We can reasonably posit that the above “array” governs gravitation .Specifically, each cell may hold one code “object”, which stores one gravitational “bend” value.
   Now, consider what might happen to the array as the universe expands. We know that it tends to be inefficient to add additional array cells.[9] For example, it would be inefficient to update an array with 42 entries, to contain 44 entries.Instead, it is far more efficient in terms of performance, to increase the values stored in each array cell.
   If we apply the *Principle of Performance Efficiency*, we can posit that the space-time grid might not have had cells added since the beginning, but instead that each stored object has had its 3 values for ‘length’ (along each space vector) continually increased over time.
   The key testable prediction here is that space-time may be “grainy”, i.e. have large quantized regions of gravity, with each region having a singular gravity value.

3. The Computed Reality Interpretation posits that locality is not fundamental, thus explaining why Quantum Entanglement is possible. I predict that additional violations of locality will be discovered. One candidate may be the “Quantum Jump”. If an experiment can be designed to measure the (cohered) position of an electron just before a jump, and then to measure the (cohered) position of the same electron just after the jump, then it should be possible to test whether the electron travelled between the two (orbital) positions faster than c, thus by definition, experimentally verifying faster than-light travel, and a second definite break with classical locality.

[9] “Dynamic Array”. Wikipedia

Summary

If the Computed Reality Interpretation offered a simple and cohesive explanation for a single quantum phenomenon, it would be a useful tool. Examples:

- The “Copenhagen interpretation” focuses mainly on just 1 phenomenon (the wavefunction), and offers a far less fundamental explanation, in that a particle in wave form can exist as a mathematical function.
- The “Many Worlds Interpretation” also focuses on the same phenomenon, and offers a far less parsimonious explanation, in that instead of positing just 1 extra reality, it posits a near-infinite amount.

However the Computed Reality interpretation does not explain just 1 quantum phenomenon. Instead it offers a simple and cohesive explanation for at least 9 key phenomena across different fields of physics. It explains, in a natural and cohesive way, not just one, but every single one of the following physical phenomena:

- How a particle can exist in quantum wavefunction form, and not exist in our reality.
- How Entanglement can break locality.
- Why time dilation occurs.
- Why gravity occurs.
- Why our reality exists (rather than does not exist).
- Why the big bang occurred.
- Why our reality has physical limits such as c.
- Why our physical laws seem permanent and not changeable.
- Why our most effective physical laws often appear to us as ‘beautiful’.

Given the above level and range of explanatory power when compared to alternative quantum interpretations, along with multiple testable predictions, and an ability to serve as an “umbrella” interpretation under which both Quantum Mechanics and Relativity can both be understood, the Computed Reality Interpretation simply demands serious attention, and if taken up by the community, might well deliver serious advances in multiple physical fields.

In addition, (and in my view most critically), the given interpretation, uniquely among quantum interpretations, is capable of opening a new line of societal communication between scientific and religious communities. This is because the interpretation can legitimately be perceived by both communities as a recognition of a “higher” reality, and to put it bluntly, “God”. Regardless of which version of “God” each community ascribes to, it does not matter - for the first time in perhaps 100 years, the two groups generally will be having a conversation around a semi-shared understanding of reality.
To put it another way identified in academic studies of persuasion, the given interpretation delivers to scientists a “social proof”[10] which can enable more effective communication with the general public.

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[10] Cialdini, Robert (2001)

And this communication improvement is existential in nature, as recognised this year by Scientific American, who endorsed a political candidate for the first time in their 175 year publication history.[11] Consider that about 40% of the U.S. public do not believe in Evolution[12], and about 28% believe that a Coronavirus Vaccine will come with a secret microchip installed for surveillance purposes[13]. In short, a significant part of the population is “Not Listening” to scientists. But the population needs to start listening, not just for the future of science and science funding by their political representatives, but in order for society to act together with great urgency to stave off the potential collapse of our shared ecosystems, economies, and interconnected nations and institutions.

[11] Scientific American (October 2020)
[12] “Level of support for evolution”. Wikipedia
[13] Sanders, Linley (2020)

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