Weirdness: Quantum Mechanics versus General Relativity

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The consensus among physicists is that General Relativity, a Classical theory, is a straightforward deterministic theory and Quantum Mechanics is weird. In this paper we present the alternative: for General Relativity, a classical theory in which the Equivalence Principle requires that a free falling frame - a non-inertial frame by definition - is to be considered as an inertial frame, its weirdness principally lies in its indispensable requirement of a space-time coordinate system in a non-Euclidean geometry.

1. On the Weirdness of Quantum Mechanics

In quantum physics it has been often stated that QM is not the final story because it doesn't explain what a measurement does!? But we know what happens when we make an observation – by injecting energy into the system, the system is perturbed. We then use a detector that gives us a distribution of the resulting quantum states of the particle – the observation. Hence we need a detector if we want to observe what is taking place. Let's not kid ourselves, even though the detector is a classical object, its interaction takes places at quantum level. And as it turns out at quantum scale, a theory of nature must be a probability theory [1].

In that paper, it was argued that in order to surmount the Heisenberg Uncertainty Principle (HUP), one would require magic. This line of reasoning can easily be extended to postulate the existence of supernatural entities who would have the power to do magic. In a universe subject to the whims of such creatures, it would be nearly impossible to use rational and empirical means to make sense of it all.

It is also often said that a particle can be at two places at the same time, but quantum physics doesn't say that. When we write the wave function as the superposition of two states, for instance, it is to take into account the possible states. We argued in this other paper [2] that the wave function, which is a solution to the Schrödinger equation, is not a real wave but its fundamental role is to provide the means to calculate the probability of a particle being in a quantum state. The quantum state represents everything you can know about a system, and the measurement corresponds to the extraction of a specific measurement. Hence the probabilistic nature of QM. And so, a real wave would collapse but a wave function, a mathematical entity, doesn't. This is further reinforced in Quantum field Theory, in which the wave function has metamorphosed into a field operator, a different mathematical entity, and the task of calculating probabilities is taken up by the propagator [3], another mathematical entity.

In the aforementioned paper [4] we also stated that the underlying principle of entanglement resides in some conservation law – momentum or spin in most cases, elucidating why there is this strong correlation observed in entangled particles. A close analogy of that situation is if you were to go on a trip, and your living partner sees that you forgot you right-foot shoe in the closet. Upon arrival at your destination, you get a phone call in which your partner tells you that you must have your left-foot shoe in your luggage. The notion of a spooky action being at play or that the state of one particle determines magically the state of another particle on a galaxy faraway should be put to rest.

On the notion of particle/wave duality: consider a photon as the smallest particle you can ever think. Regardless, it is still wiggling [5]. According to Fourier, no matter how crazy the motion is, it can be represented by a series of sine and cosine functions, and those trig functions are basically idealized waves. So a photon, a particle, will necessarily exhibit wave features. Hence, the particle/wave duality.

These considerations may not dispel entirely the weirdness often associated with quantum physics, they nevertheless serve to mitigate it, offering a more nuanced perspective to the subject.

2. On the Weirdness of General relativity

Let us start by saying that GR is not a complete theory as the Newtonian version of gravity was derived for objects (planets) within the solar system (Kepler's law). It does not explain stellar velocities within a galaxy. Unfortunately, GR contains that same flaw.

Two things to keep in mind in regard to the equivalence principle:

i) Whether an observer is in an inertial frame or in a gravitational one, the universe is open to every observer to discover the laws of nature. There is no preference, there is no special frame.

ii) The resulting field equations is coordinate dependent, particularly to a space-time coordinate system.

Let us look at the significance of that.

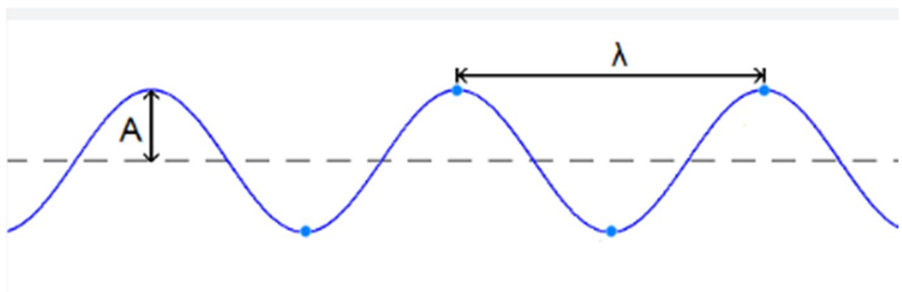
A. Space

What is space? What we need to keep in mind is the necessity of the existence of matter in regard to the concept of space. In a universe devoid of matter, space is a useless concept. Only in the presence of matter that position, distance, volume can take on meaningful values. We measure distance by inventing a standard stick (the meter), and compare all other measurements to that stick. And volume is just the cubic value of that meter. Position is determined by an arbitrary coordinate system, another concept invented of the human mind.

B. Time

What is time? You need matter in motion to fully understand this concept. In a universe devoid of motion, time is a useless concept. In that universe, one would not be able to distinguish one moment of time from another moment in time. Motion is what we observe in the universe, while time is a concept. Don't we feel the ravage of time as we are getting old? What we experience is changes that our body goes through while the earth is undergoing two specific motions: one is the rotation on its axis, or spin, giving us day and night; and the second is orbiting the sun, giving us four seasons. Our calendar is just a bookkeeping exercise: in effect, it's a one-to-one correspondence between the days that spread across the yearly calendar and these two earthly motions.

Furthermore, we can make the statement that a clock is then a device with internal moving parts (IMPs) that conveniently facilitates the measurement of motion [6]. And for that to happen, one concern is how do we get to have a reliable clock? Or how do we get a clock that beats regularly?



Besides being linear or chaotic, most importantly motion can be circular, oscillatory or wavy − motions that can be regular: they repeat a pattern that is symmetric. With that at hand, the internal moving parts in a clock (IMPs) can produce a series of waves as in the above picture. What we need is a ruler: to make sure that the amplitude A is the same throughout, and ditto for the wavelength λ. And then we have a clock that beats regularly. We call this a standardized clock because against it, we can measure the velocity of any object in the universe. Note: we need a ruler (space) and the internal moving parts in a clock (motion) to have a reliable method to measure motion in a standard way.

C. Space-time

The time coordinate in a Minkowski diagram is really a spatial coordinate, which is the distance light would travel at a given time.

Space or time, let alone the hybrid combination of space-time, are not a thing. The fabric of space-time is a very creative imagery but any illustration depicting a space-time canvas can easily convey a false narrative.

Note: space is a mental construct, time is a mental construct, and so the space-time continuum is a mental construct of two mental constructs. This hybrid space-time only exists in our imagination, as an object of abstraction.

F. Riemann Curvature of space

The curvature of space assumes that a piece of matter (earth-like sphere or potato chips) is continuous. Observation after observation have shown that space, what is between two pieces of matter, is flat.

Note: it’s crucial to understand that it's not merely space that bends (in the mathematical sense), but rather space-time itself. Consider how time undergoes dilation − within a gravitational field, time slows down. Consequently, a ray of light must traverse a lengthier, more circuitous path. The crux of Einstein’s General lies in its incorporation of time dilation within a framework of curved space-time coordinates, amalgamating two distinct concepts. Time must be integrated into the equations describing gravity. Otherwise, we're confined to Newton's notion of time as universally uniform, which it decidedly is not. The daily confirmation of time dilation by the clocks on GPS satellites attests to this fact. It's more precise to assert that it's the mathematical representation of space-time curvature that mirrors the effects of gravity. Thus, unlike the electromagnetic, strong, and weak nuclear forces, gravity occupies a category of its own. The peculiarity here stems from gravity not behaving as a force in the conventional sense but rather as a consequence of the geometry of curved space-time.

Newton’s gravity introduced the weird concept of spooky action at a distance, only to be supplanted by Einstein’s gravity with the weird concept of curved space-time. So it appears that we haven’t got rid of the weirdness. But unlike the weirdness in QM, where it arises more often than not as a consequence of misunderstanding, the weirdness in GR will persist until a revolutionary new theory of gravity emerges and offers verified empirical predictions. Until such a theory materializes, when it comes to weirdness, GR stands as the reigning champion when compared to QM.

References

[1]Palazzo Joseph, 2023-10-02, Why Quantum Mechanics Must Be a Probability Theory, https://vixra.org/abs/2310.0008.

[2} Palazzo Joseph, 2016-08-25, The Collapse of the Wave Function, https://vixra.org/abs/1608.0350.

[3] Palazzo Joseph, 2020-02-12, Physics: From Classical to Quantum, chapter 12, AuthorHouse.

[4] Palazzo Joseph, 2016-08-25, The Collapse of the Wave Function, https://vixra.org/abs/1608.0350.

[5]Palazzo Joseph, 2023-10-02, Why Quantum Mechanics Must Be a Probability Theory, https://vixra.org/abs/2310.0008.

[6] Palazzo Joseph, 2020-04-12, The Real Nature of Time, https://vixra.org/abs/2004.0278.