MULTI WORLD INTERPRETATION OF QUANTUM MECHANICS

- SAI MIHIR .J

It is most extraordinary, alluring and thought proving of all the ways in which quantum mechanics has been interpreted . In its most familiar guise, the many-worlds interpretation or the MWI suggests that we live in a near- infinity of universes, all superimposed in the same physical space but mutually isolated and evolving independently . In many of these universes, there exist replicas of people , you and me , all but indistinguishable yet leading other lives.

But, where did it all start ?

We all might have heard of this man , especially in our high school days when we were taught about atoms and electrons . Erwin Schrodinger , the Austrian physicist who developed several fundamental results in the field of quantum theory : the Schrodinger equation , which provided a way to calculate the wave function of a system and how it changes dynamically with time . In 1952 , Erwin Schrodinger gave a lecture in Dublin in which at one point he jocularly warned his audience that what he was about to say might “seem lunatic” . He went on to assert that what equation that won him the Nobel prize seems to be describing in several histories , they are “not alternatives but all really happen simultaneously”. This was the earliest known reference to the many-worlds theory.

If Erwin Schrodinger meant that two different events don’t happen alternatively but are simultaneous, then a set of questions arise in our minds ;

You toss a coin. Can u predict beforehand if it lands on a Head or a Tail?

You role a dice. Can u tell so confidently what number will land on a dice?

In the real-world u cannot predict and u say it’s a matter of chance or what we call mathematically , “Probability”. But Things change in the quantum world. We can be at 2 or more than 2 places at the same time.

“The idea that the universe splits into multiple realities with every measurement has a become an increasingly popular proposed solution to the mysteries of quantum mechanics . But this many-worlds interpretation” is incoherent , British Science writer , Philip Ball argues in this adapted excerpt from his new book ‘*Beyond Weird*’

The many-worlds interpretation or the MWI in an interpretation of quantum mechanics that asserts that the universal wavefunction is objectively real, and there is no wave function collapse. This implies that all possible outcomes of the quantum measurement are realized physically in some ‘world’ or universe.

Taking us back to the history , this theory was first interpreted and proposed by physicist Hugh Everett and its known as the Everett interpretation or the relative state transformation. Various contrasting interpretations of the MWI such as the Copenhagen Interpretation . According to him , physical systems generally do not have definite properties prior to being measured, and quantum mechanics can only predict the probability distribution of a given measurements possible results. This act of measurement affects the system , causing the set of probabilities to reduce to only one possible value immediately after the measurement. Mathematically saying that there is a wave function collapse.

Hold on, what is a wave function? A wave function also represented as ψ(psi) represents the state of the system. It encapsulates everything that can be known about that system before an observation; there are no additional "hidden parameters". The wave function evolves smoothly in time while isolated from other systems.

Now let's come back to Copenhagen interpretation. What we can conclude by his interpretation of the MWI is that that the evolution of reality as a whole in MWI is rigidly "Deterministic". The many-worlds interpretation implies that there is a very large , perhaps an infinite number of universes . The MWI views time as a many-branched tree, wherein every possible outcome is realized .

This means that we can the coin is in both head and tail face when tossed in the air until it drops on the floor and observed.

This interpretation intended to resolve many paradoxes in the field of quantum theory , the main one being the famous "Schrodinger's cat", since every possible outcome of the quantum event exists in its own universe. According to MWI, every event in the "Schrodinger's cat" theorem is a branch point; the cat is both alive and dead, even before the box is opened, but the 'alive cat' and the 'dead cat' are in different branches of the universe, both of them being equally real, but do not interact with each other.

Let's take another example, say that an individual atom of a radioactive element will decay, but there is no way to tell precisely that when or within those ranges of probabilities that the decay will happen or take place. If we say that a bunch of atoms of a radioactive element have a 50% chance of decaying within, let's say an hour , then in an hour 50% of those atoms would be decayed. But the quantum theory tells nothing precisely about when a given atom will decay . So, coming back to the Copenhagen interpretation which talks according to the traditional quantum theory, until the measurement is made for a given atom, there is no way to tell whether it will have decayed or not. In fact, to be treated as superposed states – both decayed and not decayed. This means that according to this experiment, the MWI concludes that there must exist two universes: one in which the atom has decayed and the one in which it did not.

In fact, the Everett interpretation implies that the universe branches off each and every time a quantum event takes place, creating an infinite number of quantum universes. And that the entire universe, being a 'single- isolated system', continuously exits in a superposition of multiple states.

In conclusion, the many-worlds interpretation was a theory within quantum physics that intended to explain the fact that the universe contains some non-deterministic events, but the theory itself intended to be fully deterministic.

I clearly feel that the MWI is a non- deterministic approach to quantum mechanics as myself being an observer on each branch of the event only observed one result and cannot predict the other result except probabilistically, fearing whatever I predicted would be wrong in one of the branches. From the outside it looks like a deterministic wavefunction that contains both the branches, the one you observed and the one you were not on. But, when we look inside, we are unsure about the other branch events and by the end of the day, its just a 'Game of Chance'!