The Quantum Measurement Problem

Norman M. Witriol
Central Research Group

Abstract: The Quantum Measurement Problem can be solved if we define a new object, Partave, that replaces the quantum mechanical assignments of particle and wave to the physical objects (electrons, light, etc.) we wish to measure/describe. The properties of Partaves that are described (as being those given by Nature/Reality) as being the quantum mechanically properties actually measured for objects (like electrons, and photons), no problem exists for describing these objects once they are assigned as being a partave (instead of being assigned to being a particle or wave).

Physics historically deals with scientific realism; namely to perform measurements/experiments and "understand" the experimental results, utilizing the multiple of concepts, assumptions, and words that were developed to understand our physical environment and experiments performed over centuries. One of the most fundamental problems inherent in contemporary physical theory is the quantum measurement problem. To resolve this problem has led to metaphysics presented on the grandest thrones of interpretations. Five of the primary postulates are: 1. The Copenhagen interpretation: a collection of views about quantum mechanics, principally attributed to Bohr and Heisenberg; Quantum mechanics is intrinsically indeterministic; complementarity, wave - particle duality; a completely deterministic time evolution of a quantum non-local wavefunction using Schrodinger's equation; looking in the appropriate limit, like a classical solution; a wave, to a particle. The Born rule: the wavefunction gives probabilities for measurements; when we make a measurement the wavefunction a mathematical entity that provides a probability distribution for the outcomes of each measurement on a system, can instantaneously collapse to a point-like particle; this property like an electron collapsing from a wave, an extended wavefunction in an atom to the small spatial extension of a particle, a free electron –complementarity wave - particle duality, 2. de Broglie-Bohm's Postulate - that of pilot-waves. Here a real localized particle's motion is governed by a non-local field – the pilot-wave, that the particle surfs along, and whose time evolution is thereby being guided along a path from its initial to its final state. The pilot wave field instantly changes in response to its environment (including any measurement system). This postulate avoids the collapse assumption, but it gives 'spooky action at a distance i.e., faster than the speed of light. In addition, the particle is always somewhere. Its theory predicts the same result as the previous quantum theory with collapse. 3. Einstein, Podolsky and Rosen – spooky 'action-at-a-distance' involving the introduction of so called 'hidden variables', the theory being non-local or incomplete (preferring incomplete). All these postulates include an instantaneous (faster than light) assumption 4. Everett's "relative state theory" Postulate - formulation of quantum theory without the collapse assumption and use quantum theory's deterministic equations. Instead of assuming there is only one solution, it assumes the universe splits into many universes, all possible collapses are realized resulting in different branches of the Universe, namely many parallel Universes. If there are only two possibilities as spin up, and spin down, then the Universe splits into two Universes one in which the spin is up another in which the spin is down. This metaphysical theory is also called the Many Worlds theory, where infinitely many unobservable completely non-interacting parallel universes exist, collectively also called the Multiverse. However, there is no accepted way to handle the problem if probabilities have different values so that one universe is

more probable than another, but both occur. But the interpretation of how this occurs is not known. 5. Wheeler's proposal that the wavefunction is information of some sort but is not an actual physical object. Additionally, there are a wide range of other propositions but absent of additional experimental or observational data to prove their concepts. I offer another solution that is satisfied by all experiments and observational evidence, as it is designed to do so. It is the solution, Nature tells us how it works vs. us telling Nature how it does not behave as we think it should, and thus it is not understandable to us, and is wrong. Comprehension/understanding an entity is the ability to know and use Nature's rules determining its properties and behavior and to use them to alter that entities' relationship with its environment and alter/predict its future. A scientist tries seeing Nature's Laws and applying them to experimental measurements; not asking for beauty in the laws, as he/she interprets beauty. In the following I will describe my proposed solution.

First, to evolve theories, we need to have defined and know the objects, and their properties, we wish to measure. Our concepts are based on the entities we learned centuries ago, as an example, particles and waves. Particles, like electrons and protons, were thought of as being an abstract mathematical concept of a zero-dimensional point (having no spatial dimensions) with their entire mass, and charge concentrated in an infinitesimally small abstract mathematical point. The properties of a classical "wave" like light, were thought of as being a spatially extended moving massless object having a phase velocity moving at the speed of light, with a complex waveshape comprising a multiple of specific wavelengths (and thus frequencies). The properties of these objects were assumed to exist independently of the Universe and of any measurements we perform on them. The problem with our "understanding" of Quantum Mechanics lies in our thoughts of these entities. Namely the properties of these objects, as defined, are not the properties of the real objects, like the electrons, and light (photons) we observe in quantum mechanical measurements. To demonstrate this intrinsic problem, assume we are examining a person, but assume a mammal is not defined in our lexicon. But our lexicon does have a fish and does have a dinosaur. Thus, on examining a person we are forced to describe a person in terms of a fish and of a dinosaur. We could never "understand" the reality of a person. Similarly, in "understanding" Quantum Mechanics our "concepts" are confined by our lexicon. Similarly, we now well know the "concepts of a point particle and of a wave. But neither of them defines the entity described by a wave function and its properties in interaction with other entities, like the collapse of the wavefunction. We use our concepts of point particles and waves without thinking about them. These limitations result in our inability to "understand" scientific reality, namely limited to these concepts of particles and waves. Thus, just as to describe a person, we needed to introduce the mammal entity in our lexicon, we now need to introduce a new entry in our lexicon to describe entities in quantum mechanics. Thus, I will correct this historical error, by introducing an entity that I call a Partave, which does describe quantum mechanical entities. I will define many of their significant properties that will include the properties of a wavefunction (with non-zero) dimensions, the collapse of the wavefunction, and its properties and interactions with other similar entities.
We will thus have addressed the first concept by having a lexicon that contains the objects we actually observe in quantum mechanics, Partaves.

Now addressing the second concept, the properties of the entities we meet in quantum mechanics, partaves. Centuries ago, the following properties were thought to be intrinsic to the entities we measure, and to be independent of each other and to be able to be measured to arbitrary accuracy. So, let us investigate our knowledge of the limitations of our measurements. Proceeding to

investigate the nature of measurement and scientific realism in our Universe. Namely the classical, Copenhagen and Einsteinian interpretations, their problems, and the solution.
Some Properties of the entities we measure thought to be independent of the observer:
1. mass/energy,
2. position (space-time),
3. electric / magnetic fields
4. momentum
6. spin

However, we discovered that:
1. Frame of Reference
The values that are measured depend on our frame of reference. For example, energy/mass depends on whether we are at rest or not with respect to the entity being measured, the existence/measurement or not of a magnetic field, and its magnitude associated with its charge also depends on our frame of reference.

2. The Uncertainty Principle.
We cannot simultaneously know the spatial dimensional size of the entity and its associated momentum. A similar uncertainty occurs, of course, in time and energy.

3. Quantum Mechanics
The extraordinary successful theory of quantum mechanics is difficult to interpret in terms of our current perceptions of reality. However, we only know what we measure. Particles and Waves, or that of complementarity, are poor descriptions. We had defined what the objects can be, for example Particle or Wave. What we measure is reality – not these pre-conceived objects.

These are three different limitations to our previous concepts of Particles and Waves of the entities we measure. Thus, I now define some of the properties of a Partave.
The values of a partave we measure can depend on our relative frames of reference. The uncertainty principle gives us a basic limitation in the possible precision of our measurements of the properties of partaves due to the basic laws of nature. The prediction of measurements on Partaves, via the quantum mechanical theory, such as the location of a Partave, was, at times unknown, measurements are not necessarily non-local, that the Partave occupied an extended spatial region, and "suddenly" could collapse, to a point - a behavior – that before the twentieth century was completely unthinkable of Waves and Particles. However, these are the properties of Partaves, – the basic nature of the Universe – of Reality, and it is the Empirical Reality of Nature's entities that led to the proposed existence and definition of Partaves.

A note on the past: Instead of Einstein trying to explain why the speed of light is independent of the speed of its source, he simply accepted this as an established fact. He assumed the property of light, of the speed of light, to be a universal constant, and proceeded to work out the consequences. Similarly, we assume the property of Partaves include its wavefunctions ability to instantaneously collapse from an extended entity, wave-like, to a point-size object, particle-like. There is no need to explain this property; it is simply a fundamental principle of nature. Similarly, for all its other difficult to understand properties. Einstein observed what Nature is – not trying to tell it what it should be. Before his theory, experiments caused widespread bafflement. He changed "The

"Truths" – properties that were believed of our Universe. Similarly, we must now change the "Truths" – properties we now believe of our Universe. These "Truths" need to be changed.

By this solution described in 1-4 below, I propose that by accepting them, what Nature shows us, the Quantum Measurement Problem is solved:

1. Quantum probability of finding the entity (like an electron) at a point is given by modulus square of the amplitude of the quantum wavefunction at that point, with multiple probabilities for one partave being in multiple places at any time, superposition, and entanglement.
2. Partaves are defined to be the wave function with all its implications.
3. Instantaneous Collapse of the wavefunction describing partaves, including interference terms, entanglement, and superposition. At times, not only the entity being measured, but the measuring apparatus itself may also need to be included and considered in quantum mechanical solutions. What to include as the partave may have to depend upon what is really being measured. But at the quantum scale, all objects are partaves.
4. "Spooky" Instantaneous action at a distance is a property of partaves – by the laws of Nature, namely Reality.

Some people may call this solution not Physics. But this behavior is what Nature/Reality has told us (via results from measurements); "this is the way I am". Just like Einstein's theory about the speed of light, that it has the same speed in any reference frame – "because that is the way I am". I would note that this concept, accepting Nature as it is, instead of trying to explain it, is as simple as possible and satisfies all measurements- just like special relativity with the speed of light being constant was simple and solved the Lorentz contraction and time dilation problems.

But is there a deeper reality we are missing – like Plato's Cave analogy? Einstein, in his Theory of General Relativity, concluded that Space-Time was curved and that explained the precession of Mercury's perihelion. In addition, it predicted the deflection of light by the Sun, and much later, the gravitational red shift. This was not fairy-tale Physics as there were previous physical measurements that his theory explained, and that theory could be applied and predicted the results of later performed experiments as described. That is Physics – not fairy-tail physics. It was not a thought experiment - it was not introduced because he did not like the flat space-time theory for "beauty. Similarly, Special Relativity was not introduced for" beauty" but for Physics. In our case, the Quantum Measurement Problem, the above proposed previously offered solutions were for "beauty", being based on previous concepts of particles and waves – not for simply describing and predicting experimental results. In my proposed solution I am staying to Physics – the Laws of Nature-Reality, that measurements are providing to us and that can be applied to multiple Quantum Mechanical physical experiments, as were the Theories of Special Relativity and General Relativity.

If my proposition is not satisfying and meaningful to you, I leave as your being a philosopher (thinking of what reality is, by how you think Nature should behave) and not seeing what Reality is - by simply seeing how Nature actually behaves, through the measurements performed on multiple chosen actual physical entities/partaves, and knowing, only from these measurements, what the properties of partaves are, and how they behave, described in 1-4.

In conclusion, I am simply stating that the solution is that Reality/Nature really is what we already know and see. There is no deeper understanding, no larger Multiverse, nothing more that is

mysterious, mythical, hidden or missing. We are not in Plato's Cave. The problem has been our concepts of the entities we deal with - namely the entities we investigate are Partaves – not Particles, not Waves.

References:

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