Journal of Research in Philosophy and History
Vol. 1, No. 2, 2018
www.scholink.org/ojs/index.php/jrph
ISSN 2576-2451 (Print) ISSN 2576-2435 (Online)

Original Paper

The Emergent Aspect Dualism View of Quantum Physics: A New Ontology to Resolve the Complementarity Conundrum

Christopher W. Tyler[1*]

[1] San Francisco, Ca, USA

[*] cwtyler2020@gmail.com

Received: November 7, 2018 Accepted: November 19, 2018 Online Published: November 27, 2018

doi:10.22158/jrph.v1n2p166 URL: http://dx.doi.org/10.22158/jrph.v1n2p166

Abstract

To resolve the conceptual problem of the conflict between quantal and relativistic formulations of Quantum Physics, this paper proposes a new conceptual ontology, Emergent Aspect Dualism, that reconceptualizes the foundations of the field. Emergent Aspect Dualism is a philosophical approach that starts from the assumption is that the primary "material" of the universe is energy, which can be manifested as kinetic energy, potential energy or matter. The flow of such energy throughout the universe is described by the continuous Schrödinger Equation, but in order to account for the hierarchy of levels of organization reality, we need to invoke the concept of emergence, under which the operative principles of each level of organization of this energy are entirely dissociated from those of the levels below it, and, crucially, the functional emergence of the properties of the conscious mind that are dualistically dissociated from the underlying biochemical principles of brain organization. Rather than assigning probabilities to the quantal realm, Emergent Aspect Dualism treats probability as an operational concept that can be held only by a conscious mind, a philosophical category that incorporates the properties of a) the superposition of states and b) the collapse of this superposition once an observation is made.

Keywords

Quantum theory, emergence, consciousness, duality, probability

Bohr: *"In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our* ***experience****".*

Neils Bohr (1934, p. 18)

Heisenberg: *"The conception of the objective reality of the elementary particles has evaporated not into the cloud of some new reality concept, but into the transparent clarity of a mathematics that represents no longer the behavior of the particles but our* ***knowledge*** *of this behavior".*

Werner Heisenberg (1958, p. 95.)

Stapp: *In short, orthodox quantum mechanics is Cartesian dualistic at the pragmatic/operational level, but* ***mentalistic*** *on the ontological level.*

Henry Stapp (2009, p. 8)

Common language has an almost universal tendency to disguise epistemological statements by putting them into a grammatical form which suggests to the unwary an ontological statement. ... We call this the "Mind Projection Fallacy", and note ... [that] the attempts of physicists to explain quantum theory are reduced to nonsense by ... falling repeatedly into the Mind Projection Fallacy.

Edwin T. Jaynes (1990, p. 17).

1. Quantum Reality

The goal of this treatment is to develop a new philosophical position on the nature of reality, with an emphasis on the nature of the quantum realm in particular. It has long been recognized that the quantum realm is somehow wrapped up with, or entangled with, the consciousness of the observer—the physicist conducting the quantal experiments. Therefore a theory of quantum reality has to take into account its relationship to the observer's consciousness.

It seems, however, that this relationship has been widely misinterpreted by physicists, perhaps stemming from the analysis of von Neumann (1932). The four header quotes, two from the originators of the core Copenhagen Interpretation of quantum phenomena, are chosen to emphasize the inability of this interpretation to access the underlying physical reality: "the purpose is not to disclose the real essence of phenomena" (Bohr); "The conception of the objective reality of the elementary particles has evaporated" (Heisenberg). These are very strong statements that are nevertheless ignored by almost all quantal ontologies, which persist in treating the wavefunction with its superposition of states as an objective reality underlying the regularities of the measurements. (See the website: https://en.wikipedia.org/wiki/Interpretations_of_quantum_mechanics).

If we disavow the possibility of knowing the underlying reality, what is this to be replaced with? For Bohr it was "relations between the multifold aspects of our **experience**"; for Heisenberg, it was "a mathematics that represents no longer the behavior of the particles but our **knowledge** of this behavior". Thus, what is being described by the equations of the quantal mathematics is purely structures in the mind of the observer. One of the few modern thinkers who gives more than lip service to the full force of this limitation is Henry Stapp, whose quote highlights that "orthodox quantum mechanics is … **mentalistic** on the ontological level".

The term "ontological" refers to our understanding of the underlying reality of the experimental observations. Thus, all of these quantum theorists are understanding the underlying reality of what the

mathematics is describing as being the **mentalistic** knowledge of the experience of their observations of the physics experiments. The goal of the present paper is to take this mentalistic specification as literally as possible and elaborate it into a full philosophical position. (Note that Stapp, despite his quote, immediately reinserts an underlying physical reality, termed "process 3" to denote the dynamic of "nature's response to the [observer's] probing action". He does not, therefore follow the core mentalistic implications of these three quotes, which are indeed all from his paper; Stapp, 2009.)

2. Science as a Rational Endeavor

The development of a new ontology for quantum physics stems from the core view of science as a rational endeavor, in the sense that the primary goal of the hypothetico-deductive method is to establish a self-consistent explanatory framework for each field of study. This goal is pursued with general success throughout most fields of science, with the marked exception of the enclave of quantum physics, where self-contradiction, logical implausibility and inconsistency with other fields of physics has ruled the roost for the past century or so. This lack of rational analysis is underlined by proposal of more than a dozen mutually contrasting quantum ontologies, as specified at the quantum interpretations website cited above. The only one that can be said to avoid the most pernicious irrationalities is what may be called an anti-ontology of the strict Copenhagen Interpretation, which says that the core observations of quantum physics are *detection events* whose *probabilistic occurrences* are predicted by a set of *theoretical equations*, and that enquiry into the underlying processes or intervening variables governing the probabilities of detection events is *fundamentally indeterminate*. (Note, importantly, that the constraint of the "strict" version is that it does not allow consideration of the trajectories of defined entities in the form of particles, which would be considered to be forbidden forms of hypothetical intervening variables.).

All other quantum ontologies attempt to overcome such unsatisfying indeterminacies with one or more irrational assumptions, such as that the underlying process is simultaneously both an extended wave and a local particle, or a particle guided by a wave, or an entire new universe for every detection event relating to every one of the 10^{80} or so particles in every previous universe, and so on. Thus, the motivation for the new quantum ontology of the present paper is to bring quantum physics out of its enclave of irrationality into a new consistency with the rationality of all other branches of science. Because many of the current quantum ontologies are bound up with the mind and the nature of consciousness, to do so also requires a new philosophy of the mind, one that resolves the Hard Problem of the nature of consciousness (Chalmers, 1995) in a rational framework.

In developing this conjoint philosophy of consciousness and quantum ontology, to be termed Emergent Aspect Dualism, it should be stressed that this is a philosophical endeavor, not a quantum physics treatise *per se*. It consequently questions some deeply held beliefs about established empirical results in quantum physics without providing the full mathematical resolution of those issues under the revised interpretation.

3. Emergent Aspect Dualism

The ontology of Emergent Aspect Dualism is a philosophical approach that starts from the assumption is that the primary "material" of the universe is energy, which of course can be manifested as kinetic energy, potential energy or matter. It is important to stress, moreover, that energy is not a "substance" in the general static use of this term, but an irreducibly dynamic flux or force forming the inherently active basis of reality. The flow of such energy throughout the universe may be considered to be of the regenerative form described by the full elaboration of the Schrödinger Equation, which specifies the total energy in terms of its kinetic and potential energy components, and of Einstein's mass-energy equation, which specifies the relation between total energy and matter.

So far, this is an inherently monistic position, but in order to account for the hierarchy of levels of organization of the realities with which we are familiar, we need to invoke the concept of **functional emergence** (Mill, 1843; Lewes, 1875), under which the operating principles of each level of organization of this energy are entirely absent from the lower levels. (Thus, for example, the principles of organization of crystalline matter into the six families of crystalline symmetry are entirely absent from the laws of the flow of electromagnetic energy through space, even though there is a continuity provided by the $E = mc^2$ relation.). It is generally believed that the lower level equations project continuously up to higher levels, as the Schrödinger Equation can be used to predict the structure of the atoms of the Mendele'ev table of elements. In fact, not only cannot the Schrödinger Equation *predict* the structure of any atom, it cannot even be mathematically optimized to describe the structure of any atom beyond helium (Mills, 2008). The attempt to do so is the field of quantum chemistry, which employs a hierarchy of approximations to address specialized subcases of the web of interactions among the elementary components of molecular structures (Veszprémi & Fehér, 1999).

This failure to accurately solve the Schrödinger Equation is an example of functional emergence, the property by which the principles of operation at a higher level are completely distinct from those at the lower level of a hierarchy (even as the hierarchy has an inherent continuity of its constituent energy flow). Another example is the functional emergence of a tornado from a steady wind. The wind is a laminar flow across a large region, but when it reaches a critical point it breaks into turbulent flow and generates the vortices that we call "tornados". Once a tornado emerges, it constitutes a defined object with a location that changes over time, which is the path of the tornado. The spatial trajectory and temporal dynamics of the path form an emergent property with its own rules of operation that are not predictable from the laws that govern the laminar flow of the wind, because the turbulence that governs the formation of the tornado is well-known form of chaotic dynamics that is defined by the fact that its behavior is not predictable from the laws of laminar flow.

A more germane example is provided by the transmission of the nerve impulse, which consists of the inflow and outflow of ions at a given location on the nerve axon. The flow at each location initiates flow at the adjacent location, implementing the emergent phenomenon of a traveling wave of ionic flow at velocities up to 1 m/s when enhanced by the long-range gap mechanism of the myelin sheath.

(Given the dimensions of the nerve, this would correspond to a speed of about a million miles per hour if scaled up to the dimensions of a one-lane road.). Thus, the flow of ions constituting neural impulse is itself an emergent organization over the local potential gradients that cause the inflow and outflow of ions at a given location on the nerve axon.

Thus, functional emergence is a general principle of complex systems, such as the system of reality covered by the hierarchy of quantum physics, macro physics, chemistry, biology, neurophysiology, and the psychology and philosophy of consciousness. Each level is in many respects functionally emergent from the previous level, with its own laws of operation that are not derivable from the lower level. In particular, the operational laws of consciousness can be seen to be distinct from those of the neurophysiology of the brain from which it derives. Neuronal activity consists predominantly of local field potential oscillations and millisecond spikes, but there is nothing (or very little) that resembles either the oscillation or the spikes in the conscious experience that is our evidence for its functioning. Conversely, a primary property of consciousness is its unified "intentionality", the property of representing and understanding the flux of information about the world as structured and meaningful interacting entities. Centuries of work in what we call cognitive studies, however, have not revealed how the mind encodes the causal relationships among events in the world that are our primary understanding of "how things work". Conscious mental representation thus seems to be an emergent principle of operation of brain processes over their non-representational neurophysiological substrate.

4. Emergent Aspect Dualism and the Hard Problem

However, while necessary, this emergence alone is not sufficient solve the Hard Problem of conscious awareness (Chalmers, 1995). As is made clear, emergence is a property of many levels of physical reality, whereas consciousness is unique in being the form that we, as humans, use as mode of thinking (e.g., the process that engenders the form of behavior that generates the present document). What is it that makes this particular emergent process unique? It is not simply the complexity of its structure. The broiling infernos of the interactive processes that constitute the activity of the sun, for example, are enormously complex and highly structured, but we do not consider them to be conscious. (Or if we do so, we have no means of verifying whether this is the case). What makes consciousness unique is that it is the only process that we know from the **internal** perspective of what it is like to **be** that process (see Nagel, 1974). This subjective/objective distinction is often accepted as being incorporated in the rubric of **monistic** materialism, but its inherent unresolvability in terms of principles of operation seems to require it to be maintained as a core **dualism** in its philosophical analysis. This view is amplified in relation the paradoxes of quantum physics in the following section.

Note that the assignment of probabilities to the mind of the observer in Emergent Aspect Dualism is not in the subjective form espoused by Quantum Bayesianism (or "QBism"). That approach treats the mental probabilities as subjective *estimates* by individual observers that could take arbitrary values, depending on the individual's experience. Under the present approach, on the other hand, the

probabilities are worked out as the **consensus analysis** of the physics community, and are thus as **objective** as physics can be made. If the physics were fully worked out, it would be absolutely applicable, and each human observer would be in the position of being able to say "I know that, if I did an interference study, I would be able to predict its result precisely (within the accuracy of the calculated measurement error) by applying the applicable formulas of physics to my experimental situation". That is, the individual observer would not subjectively know the specific outcome of the interference experiment before running the calculation, but would be one of the **community** of physicists able to do this, if the question arose, based on the body of accurate physical knowledge that is ultimately held in the public (published) knowledge of the physics community. Being based in this communal accumulation of knowledge, Emergent Aspect Dualism is thus fully objective in the operational sense of that term, and does not subscribe to the woolly subjectivity of the individual limitations of knowledge that define the QBism ontology.

This deference of the individual subjectivity to the *empirical objectivity* of the physics (or other analytic) community is an important contribution of the Emergent Aspect Dualism framework to the quantum consciousness debate, because it highlights an implicit assumption in quantum physics, and in the philosophy of mind in general, that there is a Platonic **ideal** reality outside the individual subjectivity. Plato argued strenuously for the independent existence of pure forms (such as the circle and the triangle) beyond their conception in the individual mind. His forms are universals that transcend time, space and individual subjectivity. Under Emergent Aspect Dualism, Plato's view is not treated as a literal specification of an ideal domain but is instead a metaphor for the process by which the emergent subjectivity is an operational space in which it attempts to map the underlying objective reality from which it is emergent. Thus, even the most objective approaches to scientific knowledge are ultimately **subjective**, in the sense that it extends to what is knowable to the human community. What knowledge there is, is embedded in the **minds** of the practitioners, aided by symbolic storage and manipulation in the form of books, the internet and scientific modeling. (It remains to be seen whether we are on the threshold of the transfer of this subjectivity to the universe of electronic machines, but even then the largest scope of knowledge acquisition will remain subject to its operational limitations. Despite it designation, objective knowledge will necessarily remain incomplete and subjective, even down to the most rigorous laws of physics.). Thus, the accumulated knowledge of the scientific community is the closest we come to Plato's ideal domain, and remains a Kantian approximation to the functional reality of the dynamic unfolding processes of energy flux that form our universe.

In summary, then, Emergent Aspect Dualism takes the position that the elementary stuff of everything in the universe is energy, that this energy can become structured into a series of levels of emergent organization whose operating principles at each level are not derivable from the previous levels, that one of these levels is the concatenations of neural processes called brains, that brains have some particular emergent process that gives rise to subjective experience from the internal viewpoint of that process, that the emergence provides the ability to formulate questions and provide probabilistic

answers, and that the private, subjective property of this emergent process entails a dualistic philosophical treatment of its analysis.

5. Distinction from Other Forms of Mind/Brain Dualism

Notice that this form of philosophical dualism is very different from that of Descartes (1644-7), which essentially treats the matter "stuff" and mind "stuff" (*res materia* and *res cogitans*) as separate operational domains that could communicate with each other, whereas in the present view they are very much two sides of the same coin, even though the difference between the respective viewpoints (the subjective mind viewpoint vs the objective brain viewpoint) may entail very different descriptive properties of the observables. An example of such a difference in observables is the **continuity** of the subjective impression of a light field such as the sky, in contrast to the discrete **pixellation** of its objective neural encoding by the individual receptors of the retina and the visual cortex. Since the only information available to consciousness is from the discrete receptor axons, we are unaware of the sometimes large gaps between the discrete pixels. (Objective neurophysiology tells us that only ~10% of the photoreceptors are able to signal the blue of the sky, for example, yet we see it as a **continuous** blue field. Consequently, the experiences of continuous fields of color are **emergent** from the underlying operational principles of the discrete sampling by the photoreceptors.). Thus, a substantial difference in the characterization of properties should not be taken as evidence that the subjective and objective realities are made of different "stuff", only that they are derived from different **viewpoints** on what may be the same underlying "stuff".

In a previous paper (Tyler, 2015) the present philosophical position was termed "Emergent Dualism" without an awareness that this term had already been adopted by Hasker (1999) for a more radical form of emergence of spiritual and mystical properties from the physical substrate. These proposals are very far from the present position, which is a fundamentally materialistic (though process-oriented) conceptualization. Or perhaps a better term would be "energistic", since the fundamental constituent of reality is presumed to be energy rather than matter. Here, the "dualism" is conceived as dual "aspects" of the unitary energistic processes, in which the brain and mind aspects emerge in the manner that physical aspects are emergent at many levels of physical analysis. A prime example of physical aspect emergence is the emergence of the material structure of atoms and their radioactivity from the fundamental energy flows of the underlying substrate, giving them an emergent property of solidity. Thus, the qualifier "aspect" has been included in the name to become the form "Emergent Aspect Dualism", designed to emphasize the process of functional emergence of the dual aspects of brain activity and mind functions from the underlying bath of chemicals, giving rise to both the neurochemical signaling complex and the mental processes. The inclusion of the "aspect" modifier is further intended to avoid the concept of radical emergence to free-floating spiritual or metaphysical entities or substances.

A key issue in Hasker's conceptualization is the attribution of causal status to mental events, a further manifestation of their independence of the underlying physical substance. Mental events are treated as an instantiation of an "emergent individual" (Hasker, 1999, p. 190). This conceptual entity is considered to be causally emergent in the sense that it can "cause things that could not be explained by the causal behavior of the neurons". Hasker's position is, however, self-contradictory, in that he maintains the fundamental identity of brain processes and the mind: "In rejecting [Cartesian substance dualism], we implicitly affirm that the human mind is produced by the human brain and is not a separate element 'added to' the brain from outside" (Hasker, 1999, p. 189). Thus, he is attempting to draw an impossibly fine distinction between a mind process that is "emergent from" the brain but not "added to" the brain.

In the present Emergent Aspect Dualism, on the other hand, any causal functionality would be **equally** attributable to the mental events and to their neurochemical substrate, the two being complementary aspects of the **same** brain process. The emergence here is the *functional* emergence of a descriptive entity, not a material emergence of an entity formed from a separate substance. In particular, Emergent Aspect Dualism would avoid Hasker's phrasings such as "the human mind is produced by the human brain" and rephrase it to the statement that "the human mind is a distinguishable aspect of human brain function", the mind being the aspect that supports the consciousness of the individual and the aspects of brain function (such as memory) that are accessible to individual consciousness. (Aspects of brain function that are **not** the mind include the physical structure of the brain and its vegetative functions, which are **not** accessible to consciousness.).

6. Emergent Consciousness and Quantum Physics

Having established the philosophy of Emergent Aspect Dualism, we may consider its implications for the analysis of Quantum Physics. As typified by the header quotes, the quantum physics of elementary particles has long been considered to be in some sense **entangled** with the properties of the consciousness of the observers. Indeed, this view has been taken to such an extreme that many believe that human consciousness itself somehow derives from the collapse of superpositions at the quantum level (e.g., von Neumann, 1932; Penrose & Hameroff, 2011). It is thought that human decisions are ultimately attributable to these fundamental collapses, and further that free will is derived from the quantum indeterminacy of Heisenberg.

At its core, this entanglement derives from the idea that the wavefunction defining the fundamental quantal energy state is a **physical** superposition of the possible detection states giving rise to its definition. Schrödinger's (1935) cat is considered to be simultaneously alive and dead in terms of actual physical states until the superposition is resolved by an observation. The resolution of this superposition of physical states is fundamentally probabilistic, with the probabilities defined by the amplitude of the wavefunction that is accurately calculable (at least in principle) for the particular physical situation. (Indeed, Feynman (1962) goes out of his way to shed the mentalistic basis of the

term by recasting the probabilities as "amplitudes", the physical outcome of the application of the Schrödinger Equation.).

Emergent Aspect Dualism takes a very different position on these issues. Rather than assigning probability to the quantal realm *per se*, it takes note of the fact that a "probability" is actually a form of answer to a question posed by a **conscious scientist**. In Heisenberg's (1963) indelible words, quantum physics is "nature exposed to our method of questioning". The answer to this questioning is the wavefunction defining the probability of detection events. But this wavefunction is not known *a priori*. It is defined as a probabilistic function that has to be based on a history of observations cumulating the numbers of **detection events** by the conscious scientist in specific situations. The resultant probabilistic wavefunction is by now very well known for simple cases (but is still dependent on further observations to determine the probability distributions for cases of any complexity, e.g., Studolna et al., 2010).

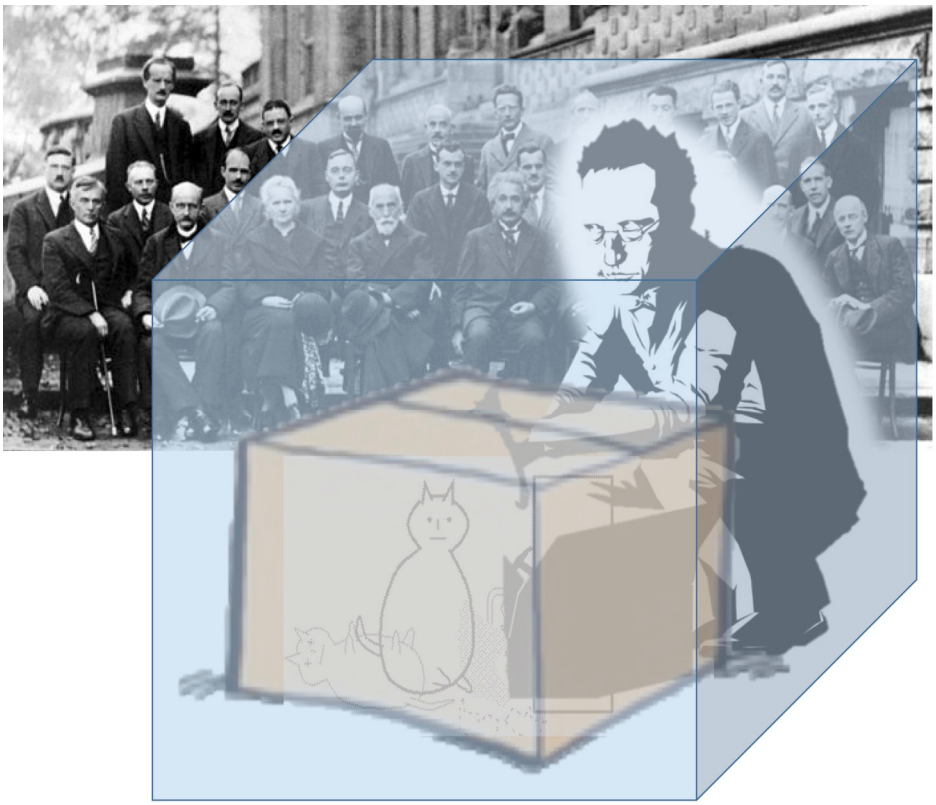

Figure 1. Depiction of Schrödinger and the Physics Community Contemplating the State of Knowledge of the Cat (Schrödinger, 1935)

However, "probability" is not physical energy. Probability is an operational mental concept held by a conscious mind, a philosophical category that is distinct from physical energy. Nevertheless, as this philosophical category of non-physical function, probability *per se* is **discrete** concept that has the

inherent properties of incorporating a) the **superposition of states** and b) the **collapse** of this superposition once an observation is made. Probability, by its nature, incorporates the simultaneous combination of the conceptual states of existence and non-existence of the observation in question, with these complementary states being superposed with probabilities of p and (1-p). Moreover, once an observation is made, this the current observation being predicted collapses the superposition to one state or the other. These two concepts apply to any form of probability, as in horse racing or weather forecasting, without reference to quantum particles. As a **mental construct**, therefore, probability embodies the key paradoxes of quantum physics in *any* conceptual domain. This parallelism should give us pause. Why should a mental concept that existed since the 18th century have the same properties as the physical reality discovered in the 20th century?

The vapidity of the physicalist interpretation of the Schrödinger's Cat paradox is highlighted by the *gedanken* concept of sealing the original experiment, together with an experimenter, in a closed room. When the experimenter opens the box within this sealed room, the superposition of states within the box collapses to one or other state (alive or dead) in the **mind** of the experimenter in the room (and, indeed, of the cat in the box), but "we", the observers outside the room, remain in a state of **indeterminacy** as to the outcome until the room is subsequently opened (where "we" is interpretable either as the solipsistic reader of these words or as the scientific community to which they are being reported). The situation can, of course, be multiplied to an indefinite "Russian doll" sequence of enclosing chambers, each with a human observer sitting in it in a state of indeterminacy until all the enclosed chambers are opened, while all the observers outside remain in the state of indeterminacy. The important inference from this configuration is that the experimental outcome is simultaneously both known and not known -the probabilistic superposition is simultaneously collapsed and not collapsed- depending on each viewpoint being considered.

This nested sequence of indeterminacy levels makes clear that the collapse is not a property that is attributable to a physical reality of the triggering quantal event, since each of the nested chambers is in a state of collapse or non-collapse, depending on whose viewpoint is adopted. Indeed, this may well be the interpretation that Schrödinger intended with his original version of the Cat parable, but the nested sequence makes the point unambiguously. To the experimenter in the sealed room, the cat's fate is determined, but to us, the outside observers, it is unresolved. At the inner level, the collapse occurred when the box was opened, but at the outer level it has not. The collapse is therefore not a property of the **physical** situation within the box, but of the **observing mind** at each level of observation. The only place that any of the collapses can be registered is in the mind of an enquiring observer; each mind in the nested sequence of chambers remains in a probabilistic superposition of states of collapse and non-collapse **until** information is received, by whatever means (which may include reading it in a scientific report), that the collapse of a registered event has occurred.

This interpretation is again in accord with the header quotes, that the "mathematics … represents no longer the behavior of the particles but our **knowledge** of this behavior" (Heisenberg, 1958). The point is further emphasized by Jaynes (1995) in his "Probability Theory: The Logic of Science":

> … the verb "is" has, like any other verb, a subject and a predicate; but it is seldom noted that this verb has two entirely different meanings. A person whose native language is English may require some effort to see the different meanings in the statements: "The room is noisy" and "There is noise in the room." … The latter statement is ontological, asserting the physical existence of something, while the former is epistemological, expressing only the speaker's personal perception. … To interpret the first kind of statement in the ontological sense is to assert that one's own private thoughts and sensations are realities existing externally in Nature. We call this the "Mind Projection Fallacy", and note the trouble it causes … as soon as it is pointed out, it becomes evident that … the attempts of physicists to explain quantum theory are reduced to nonsense by [their] falling repeatedly into the Mind Projection Fallacy.
>
> Edwin T. Jaynes (1995, p. 17).

7. Emergent Aspect Dualism as a Quantum Ontology

Thus, Emergent Aspect Dualism takes the position that the superposition of states and the collapse are properties of the "method of questioning" in the minds of the quantum physicists, which is the procedure of reading out the discrete detection probe of the detector array (such as the photographic film on which the light is being projected). Given a binary detection process and a (continuous) energy function, such a system would inherently have the properties of the quantal domain, the superposition of the mental states of detection and non-detection with a probability defined by the wavefunction at any particular position, and the collapse of this probability wherever a detection is made. The detection events remain unresolved, still in superposition, until registered by the physicists and reportable to their community as such.

Note that this novel ontology provides an immediate resolution to the paradox in the classic quantum paradox of the simultaneous collapse of the wavefunction everywhere in the universe, although it is somehow considered not to violate the Einsteinian constraint on information travelling no faster than the speed of light. If the collapse is attributed to the wavefunction as a **physical** entity, as usually is the case, this provides an impenetrable contradiction with the Theory of Relativity, a contradiction that quantum physicists generally are just forced to accept as a theoretical shortcoming. If, on the other hand, the event is a collapse of the **probability** as a concept in the mind of the physicist, that collapse applies only to the detector in question, and the wavefunction of probabilistic inference remains in force in the rest of the universe, in agreement with the observations.

The problem with the assignment of the probabilities to the mental realm is, of course, Einstein's (1905) analysis of the photoelectric effect, which was considered to be absolute evidence for the quantization of the light energy at localized points in space, rather than the detection process. This interpretation

considers the probabilities to be assigned to the physical system even in the absence of an observing mind. There is not space in the present treatment to develop an analysis of the strength of the evidence for Einstein's interpretation. Here it will only be noted that a) abandoning this one interpretation resolves a large number of other paradoxes in quantum physics, and b) that several alternative analyses of the photoelectric effect that do not require quantization of the light field have been published (e.g., Lamb & Scully, 1969).

8. Relationship to the Copenhagen Interpretation

Among quantum ontologies, Emergent Aspect Dualism is in many respects closest to the venerable Copenhagen interpretation of Heisenberg and Bohr. It nevertheless differs from them in important respects that may be addressed through the characterization found in the Wikipedia pages (since it is hard to identify more succinct authoritative sources). Consider first the summary statement at https://en.wikipedia.org/wiki/Interpretations_of_quantum_mechanics:

"Bohr and Heisenberg extended the probabilistic interpretation of the wavefunction proposed originally by Max Born. The Copenhagen interpretation rejects questions like 'where was the particle before I measured its position?' as meaningless. The measurement process randomly picks out exactly one of the many possibilities allowed for by the state's wavefunction in a manner consistent with the well-defined probabilities that are assigned to each possible state. According to the interpretation, the interaction of an observer or apparatus that is external to the quantum system is the cause of wavefunction collapse … What collapses in this interpretation is the **knowledge** of the observer and not an 'objective' wavefunction." [Emphasis added]

The position of Emergent Aspect Theory agrees with this statement in almost every detail, particularly with respect to its focus on the continuous variable of the wavefunction, its rejection of any use of the term "particle" for characterizing subatomic energy flow, and its focus on the physical knowledge of the observer.

A more detailed version of the Copenhagen Interpretation, corresponding to the understanding of many physicists, is found at: https://en.wikipedia.org/wiki/Copenhagen_interpretation. The position of Emergent Aspect Dualism (EAD) with respect to each statement is interleaved with the quoted statements.

1) A wavefunction Ψ 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 wavefunction evolves smoothly in time while isolated from other systems.

EAD: Agreed

2) The properties of the system are subject to a principle of incompatibility. Certain properties cannot be jointly defined for the same system at the same time. The incompatibility is expressed quantitatively by Heisenberg's uncertainty principle. For example, if a particle at a

particular instant has a definite location, it is meaningless to speak of its momentum at that instant.

EAD: Heisenberg's Uncertainty Principle is based on the concept of localized particles (Heisenberg, 1927), for which there is no direct evidence in electromagnetic (EM) energy. A common (but unverified) postulate of the Copenhagen Interpretation is that EM energy could consist of (1D) travelling oscillatory wavepackets. If it did so, their localizability would be limited by the Gabor limit, which specifies the trade-off between location and (Fourier) energy, or oscillation frequency. Thus, both location and energy could be known at the same instant, but to a reciprocal accuracy level. The wavepacket account of EM is nevertheless unsupported by any evidence, and there is not even a conceptual account of how to specify the local 3D structure of EM energy packets released from a local interaction as they travel through space.

For particles with defined mass, their 3D location and mass can be measured to high accuracy by means of the particle tracks observed in cloud chambers and similar devices. The position over time is specified by the track, and the energy, or momentum, is specified by the tightness of the spiral caused by the interaction between the charge of the particle and the superposed magnetic field. The treatment of such particle trajectories is, however, not integrated with their development from the Schrödinger Equation in standard physics texts, and is not obviously compatible with that formulation.

3) During an observation, the system must interact with a laboratory device. When that device makes a measurement, the wavefunction of the system is said to collapse, or irreversibly reduce to an eigenstate of the observable that is registered.

EAD: In the context of the particle trajectories if Figure 2, each point in the trajectory represents a collapse of the defining wavefunction detected by the "laboratory device" of the cloud chamber. Given this form of collapse, however, it is unclear how the trajectory can continue to propagate under the standard physicalist interpretation. Therefore the concept of the detection collapse of the wavefunction is incompatible with the existence of measurable trajectories that are the core observation of particle physics.

4) The results provided by measuring devices are essentially classical, and should be described in ordinary language. This was particularly emphasized by Bohr, and was accepted by Heisenberg.

EAD: Agreed.

5) The description given by the wavefunction is probabilistic. This principle is called the Born rule, after Max Born.

EAD: Agreed, with respect to classic detection events, which are discrete and quantized to particular energy levels. But recent studies of qubit interactions (Dolde et al., 2013; Minev et al., 2018) suggest that there is a continuous underlying energy function that is, in fact, accessible to observation of its subquantal energy levels (although only on a group EPR condensate basis).

4) The wavefunction expresses a necessary and fundamental wave-particle duality. This should be reflected in ordinary language accounts of experiments. An experiment can show particle-like properties, or wave-like properties, according to the complementarity principle of Niels Bohr.

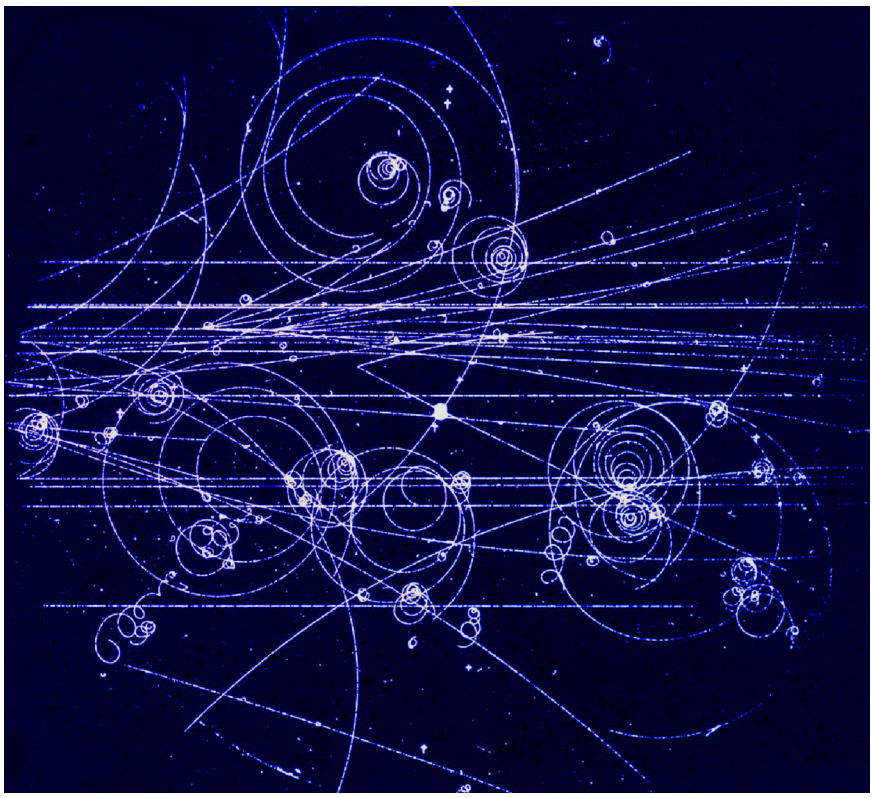

Figure 2. Trajectories in a Cloud Chamber, the core evidence for the local particle nature of individual subatomic entities, that is nevertheless incompatible with the propagation specified by the Schrödinger equation (Image from Gordon Fraser/CERN, http://cerncourier.com/cws/article/cern/28742)

EAD: The primary reality of subatomic physics is the continuous wavefunction, which does not express a wave-particle duality but defines the evolution of a continuous energy function throughout space with quantized energy levels. EAD takes the semiclassical view that the quantized detection events specified by this function are a property of the energy levels in the **detection mechanism**, not evidence for a particle duality with the wavefunction.

5) The inner workings of atomic and subatomic processes are necessarily and essentially inaccessible to direct observation, because the act of observing them would greatly affect them.

EAD: There are new approaches that allow aspects of the subatomic processes to be effectively probed (Minev, 2018), so they may not be essentially inaccessible. As with all scientific techniques, however, they should be used with a full consideration of their limitations and trade-offs.

9. Conclusion

The philosophical position of Emergent Aspect Dualism is thus a **concatenated monism** that incorporates a functional dualism engendered by the functional emergence of conscious processes from the energetic backdrop of non-conscious processes, and by the fact that the entities (ourselves) posing the philosophical enquiry of the nature of their existence are necessarily doing so from the inherent perspective of being those emergent processes *per se*. It is this inherently internal perspective of our questioning consciousness that enforces a functional dualism embedded within the axiomatic monism of its initial presumption.

Specifically, Emergent Aspect Dualism takes the position that the elementary stuff of everything in the universe is energy, that this energy can become structured into a series of levels of emergent organization whose operating principles are not derivable from the previous levels, that one of these organizational levels is the concatenations of neural processes called brains, that brains incorporate some particular emergent process that gives rise to subjective experience from the internal viewpoint of that process, that the emergence provides the ability to formulate questions and provide probabilistic answers, and that the private, subjective, enquiring property of this emergent process entails a dualistic philosophical treatment of its analysis.

The implications of Emergent Aspect Dualism for Quantum Theory are that the nature of physics is constrained to the probing of the energetic basis of reality by the emergent consciousness that is ourselves. It is inherent to its internal perspective that only such an emergent conscious process can ask questions of the nature of reality and conceptualize the answers in terms of probabilities, and that therefore the accepted properties of quantum entanglement and the superposition of states are essential properties of the concept of "probability" developed by the minds that are engaged in the probing, rather than properties of the energetic basis of the underlying processes *per se*. This last point deserves emphasis. The concept of the superposition of states that is so dear to the proponents of Quantum Physics is not, in fact, unique to that realm. It is a core property of the very concept of probability itself. Specifying a probability of any event inherently entails specifying the alternative states that it may occupy, and the weighting of their respective likelihoods. These states therefore exist as conceptual options before an observation is made, and collapse to one state thereafter. Only a conscious mind can conceptualize this analytic framework—a computer simply holds the respective structures in its registers.

Finally, it should be noted that this conceptualization removes the probabilistic superposition of states from the underlying physical reality, which is viewed as consisting a continuously variable energy function consistent with recent superconducting experiments. As such, Emergent Aspect Dualism

transcends the Copenhagen Interpretation in allowing for the measurable intervening variable of a continuous energy function mediating the quantized events of classical subatomic detection events.

References

Bohr, N. (1934). *Atomic Physics and the Description of Nature*. Cambridge University Press: Cambridge, UK.

Chalmers, D. J. (1995). Facing up to the problem of consciousness. *Journal of Consciousness Studies*, *2*, 200-219.

Descartes, R. (1644-7/1983). *Principia philosophiae (Principles of Philosophy)* (Translation with explanatory notes by Valentine Rodger and Reese P. Miller (Reprint ed.).). Dordrecht: Reidel.

Dolde, F., Jakobi, I., Naydenov, B., Zhao, N., Pezzagna, S., Trautmann, C., … Wrachtrup, J. (2013). Room-temperature entanglement between single defect spins in diamond. *Nature Physics*, *9*, 139-143. https://doi.org/10.1038/nphys2545

Einstein, A. (1905). Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt [On a heuristic point of view about the creation and conversion of light]. *Annalen der Physik*, *17*(6), 132-148. https://doi.org/10.1002/andp.19053220607

Feynman, R. P. (1962). *Quantum Electrodynamics*. W.A. Benjamin: New York.

Hasker, W. (1999). *The Emergent Self*. Cornell University Press: Ithaca, New York.

Heisenberg, W. (1927). Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. *Zeitschrift für Physik*, *43*, 172-198. https://doi.org/10.1007/BF01397280

Heisenberg, W. (1958). The representation of nature in contemporary physics. *Daedalus*, *87*, 95-108.

Heisenberg, W. (1963). *Physics and Philosophy: The Revolution in Modern Science*. George Allen & Unwin: London.

Jaynes, E. T. (1995). *Probability Theory: The Logic of Science*. Cambridge University Press: Cambridge, UK.

Lamb, W. E., & Scully, M. O. (1969). The photoelectric effect without photons. In *Polarization, Matière et Rayonnement*. Presses Universitaires de France, Paris.

Lewes, G. H. (1875). *Problems of Life and Mind* (Vol. 2). Kegan Paul, Trench, Turbner, and Co: London.

Mill, J. S. (1843). *A System of Logic, Ratiocinative and Inductive*. John W. Parker & Son: London.

Mills, R. L. (2008). Exact classical quantum mechanical solution for atomic helium which predicts conjugate parameters from a unique solution for the first time. *Physics Essays*, *21*, 103-141. https://doi.org/10.4006/1.3009282

Minev, Z. K., Mundhada, S. O., Shankar, S., Reinhold, P., Gutiérrez-Jáuregui, R., Schoelkopf, R. J., ... Devoret, M. H. (2018). To catch and reverse a quantum jump mid-flight. arXiv preprint arXiv:1803.00545.

Nagel, T. (1974) What is it like to be a bat? Philosophical Review 83: 435-456.

Penrose, R., & Hameroff, S. (2011). Consciousness in the universe: Neuroscience, quantum space-time geometry and Orch OR theory. *Journal of Cosmology*, *14*, 1-17.

Schrödinger, E. (1935). Die gegenwärtige Situation in der Quantenmechanik (The present situation in quantum mechanics). *Naturwissenschaften*, *23*(48), 807-812. https://doi.org/10.1007/BF01491891

Stapp, H. (2009). Quantum reality and mind. *Journal of Cosmology*, *3*, 570-579.

Stodolna, A. S., Rouzée, A., Lépine, F., Cohen, S., Robicheaux, F., Gijsbertsen, A., … Vrakking, M. J. J. (2013). Hydrogen atoms under magnification: Direct observation of the nodal structure of stark states. *Physics Review Letters*, *110*, 213001. https://doi.org/10.1103/PhysRevLett.110.213001

Tyler, C. W. (2015). The emergent dualism view of quantum physics and consciousness. *Cosmos and History*, *11*, 97-114.

Veszprémi, T., & Fehér, M. (1999). Quantum Chemistry: A Hierarchy of Approximations. In *Quantum Chemistry*. Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-4189-9_4

Von Neumann, J. (1932/1955). *Mathematical Foundations of Quantum Mechanics*. Princeton University Press: Princeton New Jersey, US. (Translation of the German original: *Mathematische Grundlagen der Quantenmechanik*, Springer, Berlin, 1932.)