

# Quantum Mechanics as Scientific Panpsychism

**Michael Remler**

## Abstract

The ontological separation of the behavior of matter from the matter itself, exposes a vast array of analytic and information processing implicit in the laws of physics, but otherwise not recognized as such. When the previously implicit information processing is made explicit, those resources essential to operate Quantum Mechanics are reified as the Quantum Determination Mechanism (QDM). It then allows the assumption of additional but presently unknown concepts to remove the indeterminacy derived from the Uncertainty Principle. This conceptual framework offers the QDM to explain the teleonomy necessary to make Evolution plausible and makes evident its homology to Consciousness in the mind-body problem. Because it is only a restructuring of the metaphysics of Quantum Mechanics and therefore remains tightly coupled to it, it may be a more acceptable approach than alternatives.

**Key Words:** Panpsychism, Quantum Mechanics, Born Principle, information, Evolution, teleotomy, encephalization

**DOI: 10.5281/zenodo.20051758**

174

## Introduction

### Panpsychism must come from Quantum Mechanics

In the mind-body problem discourse, panpsychism is the current preferred idea (Strawson, 2015/6). Cartesian material dualism, mind as separate non-material substance, has been out of favor for centuries because it is intellectually disjoint from physics (Israel, 2001). Materialism has lost favor in recent years as people 'face up to' the fact that there is no real way to imagine how the phenomenal reality of consciousness can arise without any antecedent (Chalmers, 1995). Panpsychism remains as the only alternative (Strawson, 2024).

---

**Corresponding author:** Michael Remler

**Address:** Dept. of Veterans Affairs, 150 Muir Rd., Martinez, CA 94553, USA

**e-mail** ✉ [mike@remler.com](mailto:mike@remler.com)

Panpsychism exists in many varieties (Goff et al., 2022). The essential feature is the existence in all matter of something which is 'proto-psych' in that it possesses the most minimal essence of consciousness from which can be assembled ultimately in humans into the Consciousness we experience. It is impossible to define that essence as it is fundamental (Schrödinger & Österreichische, 1984). The most minimal features of a panpsychist concept are that it is in intimate association with all matter, it is some kind of information about matter, the ability to process the information, and the power to control the matter.

Regardless of the philosophical nuance, if panpsychism is asserted by fiat because it is philosophically necessary, it remains unconnected to all other knowledge about reality, physics. If and only if panpsychism can be connected to physics does it have authority. To have real meaning, panpsychism must be viable in Quantum Mechanics.

### Hidden Quantum Mechanics

The physics of Quantum Mechanics is firmly established, has not only withstood multiple challenges but is accurate to as many decimal places as it can be tested (Conlon et al., 2023). In contrast, the metaphysics of Quantum Mechanics remains problematic (Weinberg, 2017). The problem is manifest in the most widely utilized metaphysics, the Copenhagen interpretation using the Born Rule, because it rests on the quicksand of a probabilistic, a random, mechanism (Hansson, 2023). In the Copenhagen metaphysics, a specific particular data occurs as a random result within a constrained probability distribution. Any one particular specific data is 'random', a synonym for 'I don't know'.

Einstein, and countless others, were and are not happy with that answer. He famously said, "I am ... convinced [God] does not play dice" (Einstein & Born, 1971). But neither he nor anyone else has discovered the rule that 'God' uses. Bohr, author of the Copenhagen interpretation, was willing to simply accept the limits of what was humanly knowable (Bohr, 1949). Caught between the fact that it works perfectly, but in some way that is fundamentally incomprehensible, the general solution has been to drop the topic, and "Shut up and calculate" (Mermin, 2004). That has produced glorious physics but ineffective metaphysics.

Does QM, especially its current metaphysical problems, offer an opportunity to find, to understand within the context of physics, the 'primordial antecedent' that supports panpsychism? Von Weizsäcker denied that the Copenhagen interpretation asserted "What cannot be observed does not exist." Instead, he suggested that the Copenhagen interpretation follows the principle "What is observed certainly exists; about what is not observed we are still free to make suitable assumptions. We use that freedom to avoid paradoxes" (Weizsäcker,

1986). In that spirit, assume that QM has a mechanism for specifically determining 'the transition from the potential to the actual' (Kistler, 2018) and call that mechanism the 'Quantum Determination Mechanism' (QDM).

To facilitate the search for the QDM, begin with the removal of the ontology of behavior of matter from the ontology of the matter itself. The QDM is now the thing that determines for a particle in which quantum state it is and will be. What is revealed about the QDM from observing what it does? Use the observable results to infer properties of a mechanism which is intrinsically not observable and apparently significantly incomprehensible. The non-observable is standard theoretical physics (Dyson, 2007). What is different here is that it is, at least in part, incomprehensible. It follows no defined rule. Following von Weizsäcker, consider 'suitable assumptions' to avoid the 'paradox' that reality, with all its complex structure, up to and including the human brain, is the product of a fundamentally incomprehensible 'random' process, and that matter devoid of any proto-psych attribute can produce human consciousness.

## **The Existential Essential**

### **Information**

A QDM is not matter. It is not a simple property of matter. It is information, the processing of information and the utilization of information. The metaphysical understanding of Information is wildly diverse (Krzanowski, 2025). As used here, the QDM is the reified embodiment of the behavior of matter. It exists as an entity interactive with the material world, but it is not matter. The ontology of the QDM, conceptualized as an 'information thing', is itself not simple. This conceptualization could be called dualist, since the QDM exists and is not matter (Ryle, 2002). However, in total distinction and contrast to Cartesian dualism, it is not asserted as the expression of first-person experience. Alternatively, the QDM derived totally from the materialism of QM, applicable to all matter, is materialism. Nor is it the hyper-abstract, unchanging ideal of Platonic ontology nor Aristotelian-Thomist hylomorphism (Larenz, 2013). It is not Russellian Monism (Alter & Nagasawa, 2012) which evades the explicit separate ontology of consciousness, but with the proto-psych feature revealed in all matter, and in that sense is clearly a variety of panpsychism (Chalmers, 2002). The ontology of non-observable entities (e.g., quarks, black holes), derived as the most parsimonious understanding of observable physics, is accepted (Kuhn, 1962). The QDM conforms fully with Burgin's Ontological Principles for Information. Most explicitly, it meets by definition Principle 1, local representation, and Principle 2, causal interactions with matter (Burgin, 2009).

The QDM is defined as a thing that carries out The Laws of Physics. Those Laws are independent of time and space. Therefore, the generality of the QDM exists outside time and space but has an interface with time and space through which information can flow. The non-material QDM has all the information regarding the matter and controls it. This metaphysical maneuver changes not one iota of the physics. Nevertheless, separating the ontologies implicitly reifies the totally abstract QM, the Laws of Physics, into a thing which makes the matter obey those laws.

### Awareness and Free Will in the QDM

The existential necessity is that the reified QDM, which is itself not the particle itself, possesses the information that the particle exists and that it controls the particle. These are the two characteristics a proto-psych entity as required by panpsychism. It possesses the two most essential properties and is relatively otherwise undefined. Those same properties, as assembled and experienced in human life, and as discussed in the mind-body philosophy, are called Awareness and Free Will. These features of the QDM, together with the cognitive and analytic methods implied by the need to implement the laws of physics, are the raw material with which to construct a QM-based model of human consciousness. With no need to alter any detail, nor to add anything to QM, if the implementation of QM is removed from disembodied abstract laws and reified as a QDM, there is no need to add a proto-psych feature; rather, it is revealed to have been there from the beginning.

## QDM in Physics

### Physical Dimensions of Information Flow

The central feature of this approach is that the QDM is ontologically not the particle, and the particle is not ontologically the QDM. Therefore, they interact. The interaction is the passage of information. By making that passage of information explicit, rather than hidden and implicit in the merged ontology, the information processing already latent in the laws of physics is explicit, and with that, what opportunities there are to remove the random features. The information passed from the particle to the QDM is its current quantum state. The QDM needs this information in order to decide if any or which change to make. The information passed from the QDM to the particle is what will be its quantum state in the next moment. This is continuous bidirectional transfer of effective information.

In order to understand the QDM better, what if any internal structure does its association with matter impose on the QDM? When two or more particles have significant interactions (i.e., atomic or chemical bonding) for a period of time, then for that period of time, their

behavior in QM is intimately interdependent such that they function as a single QDM. That is, while the particles remain separate, the nexus of information about them (their quantum states), the informational processes necessary to determine what will happen next, the information transferred to the particles to implement any changes, are all so intertwined as to represent a single informational unit. Similarly, should they interact with yet more matter, those QDMs would merge. Should the particles dissociate, the QDM would split.

However, there is in QM no natural absolute limit to the interaction of particles. In some super-infinitesimal sense, everything can be said to influence everything. However, the precision of working QM rests on the routine assumption that the theoretically valid but super-infinitesimal effects can be safely ignored without loss of real-world utility and accuracy, summarized as Bohr's 'Correspondence Principle' (Rynasiewicz, 2013). Therefore, two pieces of matter with only infinitesimal interactions may be said to be managed by 'unitary but separate' QDM. Thus, it is essential to conceive of instantaneous and fluid grouping of the QDM according to the reality of the situation. When the raw physical structure of matter changes, so must its QDM. At the macroscopic level, when a piece of matter divides, each part has a separate QDM. This possibility to conceptually merge and separate the QDMs at the macroscopic level is the interface of QM and Classical Physics.

Under ordinary circumstances, a particle in Quantum Mechanics (QM) does not live in isolation or near isolation. Therefore, not only must the QDM include information on the current state of its matter, but also of its extended environment, including the effects of the extended region that are weak but not infinitesimal. In these interactions, the analysis may usefully skip this massive specific complexity for one or another specific purposes, relying on classical and chemical concepts, but that does not mean the QM specificity does not exist, and that the specificity may be central to other issues. There is no necessity nor reason to believe the QDM does not include every detail.

### Implementing the Laws of Physics by a QDM

Obviously, the QDM must also at least have the most minimal additional capacities sufficient to implement the known laws of physics. Consider the classic double-slit experiment. We may divide QDM into an unknown part which may be predominant for the first particles and the Schrödinger wave equation part which must become more controlling of the aggregate result as the number of particles increases. In any particular moment (or experiment), the total function contains a component universal in all particulars, the law of physics, and an idiosyncratic component.

To meet the second part without violating the first part, the QDM must implement something functionally equivalent to the Kolmogorov–

Smirnov test (Engineering Statistics Handbook, 2025) to know where to place the next particle to continue to get closer to the predetermined correct continuous distribution. The K-S test will not yield a unique result. And for any one particle, the QDM placement may include to a significant degree some other factors such that the placement appears random to current analysis. Nevertheless, the aggregate collection of placements must approach the Schrödinger requirements. The QDM data must also include when this experiment started, what it has already done, produce the distribution that it must progressively approximate, and calculate the divergence of each interim data set from the continuous distribution. It must include the experimental apparatus, including the distance from the source of particles to the double-slit screen, the distance between the slits, the distance to the detector, etc. The requirement that the QDM conform to the known part of QM is in fact a very demanding information processing task.

### QDM Fluidity in Space

This array of computational and analytic properties attributed here in this QDM formulation is not a new fact. It was always there but previously described as "matter obeys the laws of physics." The difference between 'localizing' it to the laws of physics versus the QDM is that in the former it is seen as the innate order of the universe (Wigner, 1960) and in the latter as one element within the universe doing it.

179

Indeed, the QDM, even before it determines what changes to make or not make, must include all the laws of physics that constrain its alternatives. Therefore, the QDM has a vast cognition. It is beyond even speculation to understand such a QDM process in any detail. However, a number of important particular cases suggest the dynamics of QDM is anything but simple or classical. Two situations are of singular significance: entanglement and the measurement problem. Entanglement, especially as conceptualized in the EPR gedanken experiment (Einstein, Podolsky, & Rosen, 1935), makes two points about QDM fluidity. Most famously, simple physical distance does not necessarily allow simple separation of the QDM of these particles.

This discussion began with what is called the measurement problem of QM. If, when, why, and how the intrinsic uncertainty of QM is pseudo-resolved into the clarity of the observable classical world of human experience by a random process. This built into the Copenhagen Interpretation is the vexing apparent paradox of the simultaneous existence in reality of all the alternative potential results (Vaidman, 2021) until there is an unexplained collapse of the wave function (Bassi et al., 2013). This can be removed in the QDM concept simply by saying it decides immediately without any implication of any further detail beyond that decision itself. There never was

indeterminacy and therefore no resultant ambiguity and then no opportunity for the paradox of simultaneous existence of multiple alternative results. The paradox is replaced by an assumption.

## QDM in Evolution

### The Body

The mind-body problem is usually discussed as if all the problem was on the mind side. What is consciousness? But there was an equal problem on the Body, brain, side. How did it come to pass that such a complicated structure as the human brain came into existence? This is no less a problem for Panpsychism than for any other understanding. If, as Panpsychism claims, Proto-psych is everywhere, why is full psych restricted to Human brains? Why and how does the proto-psych get 'assembled' into full psych? On the Brain side, the question is, why and how does disordered matter get 'assembled' into the complex specificity of the Brain?

Evolution is usually understood in two phases: the first stage, abiogenesis, the formation of single-cell organisms from a primeval mush devoid of even complex molecules, and a second stage, speciation, the development of progressively more complex species, ultimately, human beings. Both are said to be driven by some variety of spontaneous random variation and the resulting population culled and shaped by some variant of natural selection. The documentation of the historical evolution of speciation is absolute, but abiogenesis is substantially without historical data. Without a non-random mechanism, abiogenesis would be "a stupendously improbable chemical outcome whose likelihood of repetition would be virtually zero" (Pross & Pascal, 2013). In speciation, the concept that spontaneous random variation would provide a sufficient variety of alternatives from which natural selection may choose is credible but problematic. The variety of theoretical non-random mechanisms of variation proposed is clear testament to its perceived improbability (Walker, Packard, & Cody, 2017).

### Random is Improbable

The paradoxes resulting from the pure probability in the Born rule have been replaced with the assumption of a QDM to be specific. The resources intrinsic to the QDM to give specificity have been identified. The specificity itself remains unknown. Therefore, we must focus on a specific paradox we seek to avoid in order to make further 'appropriate assumptions'. The paradox is why and how did an apparently random process of matter produce the highly non-random structure of the human brain and with that material brain produce the highly non-material reality of human consciousness; to move from the "stupendously improbable" to the fully plausible.

The additional 'suitable assumptions' needed to 'avoid the improbability of Evolution paradox' must be formulated with a generality of applicability to apply equally well to the disorder of the interior of a star, the hyper-specificity of any individual human's thalamus, and not tailored to the specificity of evolution. The assumption must be effective but still appear as if it was random. Given the vast analytic and mathematical resources needed just to follow the laws of physics, it could be highly complex or vague and broad. Regardless of how any additional factor is conceived, what is necessary to remove the paradox is that they strengthen the specificity and produce a positive non-linearity of the relationship between the QDM and the changes in the associated matter. That is, each change in matter resulting from the application of the specificity can facilitate and/or augment a subsequent application of the specificity.

This non-linear synergy, built on the 'back causality', resolves the Evolution paradox, the massive improbability of Evolution, especially the abiogenesis phase. That 'success' of building in matter resources consonant with the QDM's native structure is an environment that leads to more of like matter, a positive feedback loop. This transforms the core standard engine of Evolution theory from merely the persistence of stable molecules and self-reproducing molecules to a goal-oriented dynamic process.

The standard concept that in the first phase of chemical evolution, spontaneous random bonds, augmented going forward only by stability and self-reproducibility, challenges credibility (Witzany, 2016). The theory of self-assembly of cells bounded by membranes is not credible (Caliari, Xu, & Yomo, 2021). Speculation in the context of the QDM in contrast to 'random' is that almost any conceivable value that the QDM might utilize to specify any change—stability, growth, etc.—would serve to make it maximize the progression of abiogenesis in comparison to simple random. This mitigates the improbability paradox intrinsic to the idea of the emergence of the essential precursors of life by a purely random process.

### Positive Feedback

The three assumptions: 1) The reification of the processes of QM as the QDM to reveal what is implicit in the 'Laws of Physics'; 2) The assumption in the QDM of a mechanism to determine a specific result and remove the paradoxes of probability; and 3) The QDM rule is positive and cumulative; have the effect of the positive feedback on the QDM side resulting in a process with teleonomy (Pross, 2012). It says the process of natural selection is offered a menu of options generated in response to immediate stresses evident at a relatively basic chemical level which is goal-oriented to maximize the other factor. This again mitigates the improbability, the paradox, of the emergence

of the progressively more complex life forms by a random process. Natural selection remains as the process defining the result.

The emergence of cell membranes in evolution marks the transition from abiogenesis to biological evolution, the transition from inanimate matter no matter how complex, to life. The membrane must also determine a natural classical limit on the QDM. The matter inside the membrane is far more tightly associated than any part is with any matter outside.

The emergence in life of the phenomenon of death suggests there is a qualitative difference in the internal organization of the QDM associated with the emergence of the cell membrane, the sharp distinction between the matter controlled by the QDM and even immediately adjacent matter. The informational activity of the QDM of the inside may include information derived from outside the membrane, but it is not derived from or based on its QDM nature. It is the dual management of information from inside and outside the QDM whose matter directed by the QDM is sharply delineated by a cell membrane that is the first step from which to assemble proto-psych into a model of consciousness.

## **The QDM in Consciousness**

### **One and Many**

From the mind-body perspective, in the panpsychism context, the fluid grouping of QDM in response to the reality of the matter they control immediately solves the so-called 'combination problem'. First and foremost, the QDM was never atomized. It was never in need of 'combination'. The issue from the mind-body perspective is the delimitation of the generality of the universal QDM into many effectively separate units associated with separate bodies suitable to be restructured as a unified consciousness. Again, that problem is removed by the 'Correspondence Principle'. The classical physics delineation of each separate person will correspond to the delineation of each separate QDM, consciousness.

There remains the organization of the fluid aggregated proto-psych of the separate QDM into the full and unified Consciousness evident in the corresponding humans, the mind. On the Body side, we do know it correlates with the encephalization of living beings. The QDM manages not only the information to run the matter inside but also the information available at the surface, e.g., temperature, pH, etc., alongside 'endogenous information'. Also, the evolution of sensation and mobility initiates a flow of information from outside the body from the external world to the QDM. That information in the now QDM/matter synergistic unit including, sensory like vision or intention, like motor activity, are marked in the information as non-native to the now purely information compartment QDM. In humans,

they are marked with qualia, but managed like native information, thinking (Tye, 2025).

The most revolutionary effect of the external information is the restoration of communication between functionally separate QDMs. As emphasized in the first part of this discussion, QDMs in inanimate matter are highly fluid in functionally in terms of what matter they interact with, but that is lost with the rise of the cell membrane. This is evident even in the plant kingdom (Bacheva et al., 2025). The progressive evolution of that information flow from outside into the relatively sequestered QDM/matter synergy is manifest on the Body side in the animal kingdom as the progressive encephalization. In the context of animal behavior and their communication, this becomes the dominant information organizing factor (bee hives, bird flocks, etc.). Thus, the QDM/matter synergy, the information structure of the individual, can be and is dominated by these external factors.

When and how is the proto-psych aspect of the QDM organized in a unified human consciousness? This question exists in parallel as an ontogenetic question in each individual and as a phylogenetic question of the human species. There is irreducible ambiguity, variation, and specificity within the concept of consciousness. There is some degree of agreement that the modern understanding of Consciousness, as an issue within the mind-body problem discussion, is, as famously articulated by Descartes, referring to the highest level of Consciousness, self-consciousness, awareness of self (Smith, 2024). That ambiguity is compressible only by considering a continuous and variable spectrum from proto-psych to full self-reflective manifest in evolution (Veit, 2023) and in personal development (Marraffa & Meini, 2024).

In the mind-body context, the focus is on the individual adult human since that is where the issue arises. Nevertheless, it is impossible not to utilize the evolutionary development perspective for guidance (Gould, 1977). Except perhaps for some theological perspectives, no one thinks a human zygote, at the moment of conception, is any more conscious than a single-cell organism. At birth, a human has an extremely incompletely developed brain compared to a mature human brain. It is common to compare it to a rat's brain in terms of many ontogenic markers. Others have said this is misleading because it has many features of a newborn primate, but since it has so much post-uterine development, its cellular developmental activity is as if it were more immature (Gomez-Robles et al., 2023).

In this formulation, there are three factors driving the process. First, the native 'order seeking' property of the QDM as discussed primarily in the context of Evolution. Second, the material structure of the Brain as developed in Evolution to facilitate the order seeking. And thirdly, the information into the developing individual through the matter which can change the organization of the QDM. It is inconceivable that a newborn human brain with organizational properties little if any

more sophisticated than a mature rat or newborn primate can generate modern adult human Cartesian self-consciousness. Therefore, that singular 'Cartesian Consciousness' is a product of postpartum maturation in a post-civilization environment dominated by flow of external information.

Given this phylogeny and ontogeny, Consciousness must be understood to exist in a vast variety of forms. The iconic crystalline brilliance of Descartes' "I think, therefore I am" has hidden the diversity of components of consciousness within any one human being, within the variety of adult contemporary humans, and in the rest of the animal kingdom. Within any one person, there are perceptual consciousness, cognitive consciousness, and even unconscious consciousness (fear, lust, etc.) (Montemayor, 2021). And if each person's consciousness is developed in the context of their postpartum existence, then human consciousnesses are as varied as those personal histories. Indeed, given the specificities of critical periods in human psychological (Piaget & Inhelder, 1973) and neural development (Wiesel & Hubel, 1963; Hubel & Wiesel, 1963), all human consciousnesses are different. Given the 'deep homology' of human and animal evolution and individual development, there can be no doubt their consciousnesses overlap in part.

### The Meta Metaphysics

It is important to consider the metaphysics of this structure since that is the whole motivation. As Einstein's metaphor makes explicit, the problem of how to think rationally about the unknowable and the incomprehensible exists in many other distinct forms. It can be reasonably said that the effort to think rationally, to 'comprehend' a problem defined as 'incomprehensible' is literally a contradiction in terms and best dropped. The superstitious and theological approaches to similar, if not identical, questions contaminate the question itself beyond the tolerance of many of the best minds. The premise here is to follow von Weizsäcker and remain anchored in QM.

The metaphysical problems derived from the indeterminacy in QM extend beyond the issue itself. The problem of 'random' in the metaphysics of QM arises in Evolution as well as the mind-body problem. The 'Heisenberg Uncertainty Principle', the 'Mechanisms of Evolution', and 'The mind-body problem' are three perspectives on a very similar metaphysical problem: the interface between the currently knowable and unknowable aspects of reality. From many perspectives, people perceive 'The Unity of Nature' (Weizsäcker, 1981).

The trick of separating the ontology of the QDM from the ontology of its matter was done primarily to display explicitly the reality hidden when they are merged. In fact, since the science is unchanged except for the addition of assumptions, one can revert the separation and retain what has been revealed. That is, there is no Evolution

Teleonomy Paradox or mind-body problem. Both are of the nature of reality no less than Newtonian Mechanics if the minimal plausible assumptions regarding what is currently unknown can be sustained.

The real problem is how to conceptualize the reality. Conceptualization of reality is a structure of public ideas. The varieties of Consciousness are diverse, but contemporary ideas regarding related issues are too idiosyncratic to be integrated in science (Remler, 2025). Therefore, the meta metaphysics is a free choice. Russellian Monism, everything is just a feature of matter, is an easy choice. If we focus on the complexity of the QDM producing the orderly behavior of matter, we have a total but still secular meta metaphysics (Spinoza, 2002). A wide variety of conceptual structures can support essentially identical metaphysics.

## Acknowledgements

I am very grateful to Prof. Alexander Givental for his helpful feedback and discussion on earlier drafts of this paper. I would also like to thank the reviewers for their very detailed and constructive comments.

## References

- Alter T, Nagasawa Y. What is Russellian Monism? *Journal of Consciousness Studies*. 2012;19(9-10):67-95.
- Bacheva V, Rockwell FE, Salmon JB, Strook AD. A unified framework for hydromechanical signaling can explain transmission of local and long-distance signals in plants. *Proceedings of the National Academy of Sciences*. 2025;122(17).
- Bassi A, Lochan K, Satin S, Singh TP, Ulbricht H. Models of wave-function collapse, underlying theories, and experimental tests. *Reviews of Modern Physics*. 2013;85(2):471-527.
- Bohr N. *Discussions with Einstein on Epistemological Problems in Atomic Physics*. In: Albert Einstein: Philosopher Scientist. Cambridge University Press; 1949.
- Burgin M. *Theory of Information - Fundamentality, Diversity and Unification*. In: World Scientific Series in Information Studies. Vol 1. 2009.
- Caliari A, Xu J, Yomo T. The requirement of cellularity for abiogenesis. *Structural Biotechnology Journal*. 2021;19:2202-2212.
- Chalmers D. Facing up to the problem of consciousness. *Journal of Consciousness Studies*. 1995;2(3):200-219.
- Chalmers D. Consciousness and Its Place in Nature. In: Stich SP, Warfield TA, eds. *The Blackwell Guide to Philosophy of Mind*. Blackwell Publishing; 2002:102-142.
- Conlon LO, Vogl T, Marciniak CD, et al. Approaching optimal entangling collective measurements on quantum computing platforms. *Nature Physics*. 2023;19:351-357.
- Dyson F. Why Is Maxwell's Theory So Hard to Understand? In: 2nd European Conference on Antennas and Propagation; 2007:1-6.
- Einstein A, Born M. Letter from Einstein to Max Born, 3 March 1947. In: *The Born-Einstein Letters*. 1971:157-158.

- Einstein A, Podolsky B, Rosen N. Can quantum-mechanical description of physical reality be considered complete? *Physical Review*. 1935;47:777-780.
- Engineering Statistics Handbook. Kolmogorov-Smirnov Test. Accessed December 10, 2025. <https://www.itl.nist.gov/div898/handbook/eda/section3/eda35g.htm>
- Goff P, Seager W, Allen-Hermanson S. Panpsychism. In: Zalta EN, ed. *The Stanford Encyclopedia of Philosophy*. Summer 2022 ed. Accessed December 10, 2025. <https://plato.stanford.edu/archives/sum2022/entries/panpsychism/>
- Gomez-Robles A, Nicolaou C, Smears JB, Sherwood CC. The evolution of human altriciality and brain development in comparative context. *Nature Ecology & Evolution*. 2023;8:133-146.
- Gould SJ. *Ontogeny and Phylogeny*. Belknap Press; 1977.
- Hansson J. The Magical "Born Rule" and Quantum "Measurement": Implications for Physics. *Foundations*. 2023;3:634-642.
- Hubel DH, Wiesel TN. Receptive Fields of Cells in Striate Cortex of Very Young, Visually Inexperienced Kittens. *Journal of Neurophysiology*. 1963;26:994-1002.
- Israel J. *The Collapse of Cartesianism*. In: *Radical Enlightenment: Philosophy and the Making of Modernity 1650-1750*. Oxford University Press; 2001.
- Kistler M. Potentiality in Physics. In: Engelhard K, Quante M, eds. *Handbook of Potentiality*. Springer Netherlands; 2018:353-374.
- Krzanowski R. Information - Modern Theories. *Computer Science*. 2025;26(2).
- Kuhn T. *The Structure of Scientific Revolutions*. University of Chicago Press; 1962.
- Larenz R. What Can Thomistic Philosophy of Nature Contribute to Physics? *Societal Studies*. 2013;5(2):481-499.
- Marraffa M, Meini C. Self-Consciousness as a Construction All the Way Down. *Brain Sciences*. 2024;14(3):200.
- Mermin ND. Could Feynman Have Said This? *Physics Today*. May 1, 2004.
- Montemayor C. Types of Consciousness: The Diversity Problem. *Frontiers in Systems Neuroscience*. 2021;15:747797.
- Piaget J, Inhelder B. *Memory and Intelligence*. Pomerans A, trans. Routledge and Kegan Paul; 1973.
- Pross A. *What is Life?* Oxford Press; 2012.
- Pross A, Pascal R. The origin of life: what we know, what we can know and what we will never know. *Open Biology*. 2013;3(3):120190.
- Remler M. Abstraction and the Explanatory Gap: Physicalism and Dualism Combined. *Journal of NeuroPhilosophy*. 2025;4(1).
- Ryle G. *The Concept of Mind*. University of Chicago Press; 2002.
- Rynasiewicz R. The Correspondence Principle. Presented at: 100 years of the Bohr atom, 1913-2013; June 2013; Niels Bohr Archive. Accessed December 10, 2025. <https://philsci-archive.pitt.edu/9961/1/TheCorrespondencePrinciple.pdf>
- Schrödinger E, Österreichische Akademie der Wissenschaften. *Erwin Schrödinger: Collected Papers. Vol 4. General Scientific and Popular Papers*. Verlag der Oesterreichischen Akademie der Wissenschaften; 1984.
- Smith J. Self-Consciousness. In: Zalta EN, Nodelman U, eds. *The Stanford Encyclopedia of Philosophy*. Summer 2024 ed. Accessed December 10, 2025. <https://plato.stanford.edu/archives/sum2024/entries/self-consciousness/>
- Spinoza B. *The Complete Works*. Shirley S, trans. Hackett Publishing; 2002.

- Strawson G. Mind and Being: The Primacy of Panpsychism. In: Brüntrup G, Jaskolla L, eds. Panpsychism: Philosophical Essays. Oxford University Press; 2015/2016.
- Strawson G. Consciousness and Its Place in Nature: Why Physicalism Entails Panpsychism. 2nd ed. Freeman A, ed.; 2022.
- Tye M. Qualia. In: Zalta EN, Nodelman U, eds. The Stanford Encyclopedia of Philosophy. Fall 2025 ed. Accessed December 10, 2025. <https://plato.stanford.edu/archives/fall2025/entries/qualia/>
- Vaidman L. Many-Worlds Interpretation of Quantum Mechanics. In: Zalta EN, ed. The Stanford Encyclopedia of Philosophy. Fall 2021 ed. Accessed December 10, 2025. <https://plato.stanford.edu/archives/fall2021/entries/qm-manyworlds/>
- Veit W. A Philosophy for the Science of Animal Consciousness. Routledge; 2023.
- Walker SI, Packard N, Cody GD. Re-conceptualizing the origins of life. Philosophical Transactions A Mathematical, Physical and Engineering Sciences. 2017;375(2109):20160337.
- Weinberg S. The Trouble with Quantum Mechanics. New York Review of Books. January 19, 2017:51-53.
- Weizsäcker C. Unity of Nature. Farrar Straus Giroux; 1981.
- Weizsäcker C. Quote cited in: Cramer J. Reviews of Modern Physics. 1986;58:647-688. Accessed December 10, 2025. [https://www-users.york.ac.uk/~mijp1/transaction/TI\\_20.html](https://www-users.york.ac.uk/~mijp1/transaction/TI_20.html)
- Wiesel TN, Hubel DH. Effects of visual deprivation on morphology and physiology of cells in the cat's lateral geniculate body. Journal of Neurophysiology. 1963;26(6):978-993.
- Wigner E. The Unreasonable Effectiveness of Mathematics in the Natural Sciences. Communications on Pure and Applied Mathematics. 1960;13(1).
- Witzany G. Crucial steps to life: From chemical reactions to code using agents. BioSystems. 2016;140:49-57.