Unity and Multiplicity – Henri Bortoft - Wholeness and the Double Slit Experiment

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Abstract

In this paper, we appreciate Henri Bortoft's understanding of how in coalescence there is a disclosure of the whole and how this viewpoint is an entry into thinking and perceiving from the whole. We describe how the ambiguity of One and Two in Young's experiment is handled by Bortoft and how it is handled in quantum theory formalism. The quantum theory that has come about in relation to the Young's experiment is a mixture of the epistemology of compresence and coalescence. The paper makes an initial foray into describing aspects of quantum theory from the point of view of the disclosure of the whole. Background for this paper is found in our previous paper [21] and we will to carry this investigation of quantum epistemology further in subsequent work. Bortoft's mode of holding the part and the whole is deeply relevant to physical understanding.

1 Introduction - Compresence and Coalescence

Key to Bortoft's approach to physics [2] and in particular to his approach to Young's double slit experiment are the concepts of compresence and coalescence. In both cases these are conditions relative to a conscious observer whose state of observation can be described by one or the other of these terms.

In compresence there are located apparently independent objects, spatially separated and simultaneously present. Such objects appear outside an observer and thus there is invoked an apparent boundary between an observer and those objects. Thus do I see the papers on my desk, the clouds in the sky or the letters appearing on the computer screen at which I type.

In coalescence objects are intrinsically joined in the condition of disclosure. Thus the moon (as I see it) and the lens system in my telescope are in coalescence for my seeing of the moon through that telescope. Just so my concepts of geometry are in coalescence with my seeing in my mind's eye the proof that the sum of consecutive odd numbers is a square as in $1 + 3 + 5 + 7 = 16 = 4^2$. We see through the conceptual geometry to the unity of our understanding of a mathematical fact. We see through the patterns associated with specific examples to the generality of a theorem. We see through and are coalesced with our eyeglasses in order to see the sunset. The whole is disclosed in the unity of coalescence.

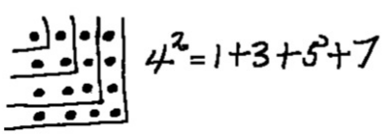

Figure 1: Geometry of the Sum of Odd Numbers

Coalescence is to perception as metaphor is to the essence of poetry. In "Juliet is the Sun." the statement of the coalescence of Juliet and the Sun allows us to see Juliet through the Sun and to see the Sun through Juliet. When Juliet and the Sun are in coalescence they are not identical and yet they are not apart. They are two and yet they are one. The same can be said for an understanding of Number through Geometry or my seeing the rings of Saturn through that telescope. New unities arise in the condition of coalescence.

Consider the story of the atom. First there was the Bohr theory of a compresent orbiting electron, flying about in circular and elliptical orbits about the positively charged nucleus. Bohr's electron was not allowed to radiate as an accelerated charge but this was inconsistent with the rules for the compresent electron in the classical theory. After De Broglie and Schrodinger the electron is coalesced with the nucleus in a possibility of discrete energy states. The electron is a standing wave for its own quantum wave function. The electron does not have independent existence in the atom. The electron relinquishes its independence for the state of union that is the atom. Classical rules do not apply because there is no thing to accelerate in the atomic electronic state. De Broglie saw how this could be in thinking about the standing waveforms of a violin string. These are fixed points, eigenforms, places of stability. But where is the observer we hold so dear in trying to think in the quantum way? The Schrodinger explanation of the atom does not require an observer. We can observe photons emitted by the atom, but we do not directly look at the atom. And yet it is coalesced and this coalescence is happening because we do not observe. The atomic state is coalescence happening in the absence of the classical cleft and cut. The reality of the atom reveals the unreality of the electron as particle and reveals the reality of coalescence as state prior to the making of the distinctions so dear to the observer.

David Bohm, in discussing the concept of the implicate order [3] , discusses how a form of coalescence can be part of the objective ontology of a physical world. He gives the following example: "This device consisted of two concentric glass cylinders, with a highly viscous fluid such as glycerine between them, which is arranged in such a way that the outer cylinder can be turned very slowly, so that there is negligible diffusion of the viscous fluid. A droplet of insoluble ink is placed in the fluid, and the outer cylinder is then turned, with the result that the droplet is drawn out into a fine thread-like form that eventually becomes invisible. When the cylinder is turned in the opposite direction the thread-form draws back and suddenly becomes visible as a droplet essentially the same as the one that was there originally." (D. Bohm 1980, "Wholeness and the Implicate Order" [3] p. 329)

In this example, a droplet of ink is enfolded into glycerine in such a way that the ink and the glycerine form an undivided whole, and yet the process can be reversed so that the drop is retrieved. We can say that the glycerine and the droplet can be shifted between compresence and coalescence. In this case the coalescence does not depend upon the presence of an observer. It is characteristic of physical analysis that one might search for a way to see how the world would be an undivided whole from which physicality and the condition of observation would both emerge or emerge together. Thus for Bohm, there is a physical world in which the implicate may be the most fundamental state, and from that implicate observers extract the specifics of compresence that are related to measurement and experiment.

Henri Bortoft [2] states that in compresence we arrive at a terminus that is a disclosure of the whole. This way of speaking of observation in relation to the whole does not break the observation into an observation of a this or a that that is already given in compresence. We quote Bortoft on these points.

2 Bortoft Quotes

> “OBJECTIVE To demonstrate that:
> (i) Young’s optical experiment has never been described.
> (ii) Young’s optical experiment can never be described in a language with the numerical singular / plural distinction.” [2], p.244

(Young’s experiment, the double slit experiment, has a source of light (or electrons) that can be accessed through two slits in a wall and observed from a vantage where the distinction between the two slits cannot be perceived. Under such conditions an interference pattern is seen at the screen of observation.)

> “The mode of connexion which is necessary to compresence is the local intermediary. The connexion between the elements of a compresence is made by another element which is itself compresent with the elements it serves to connect. Thus the connexion in compresence is an element of the compresence it connects.” [2], p.223

“Coalescence: elements are said to be in coalescence when they manifest within a whole, that is within a totality which is such that elements cannot be added or removed.” [2], p.225

“The term ’coalescence’ refers specifically to the mode of togetherness of the totality. But a totality which is constituted in this mode can be referred to nominally as "a coalescence’.” [2], p.225

“An image is not a thing (it-self is not!). We do not have three things: pin, lens, image. The image of the pin in the lens is the optical closure of the pin and the lens together into a whole. The image emerges as a total encompassing of the pin and the lens in an optical whole, so that it (the image) is the disclosure of the pin and the lens within the whole. The image is the coalescence of the pin and the lens.” [2], p.225. See Figure 2.

Figure 2: Pin, Lens and Coalesence

“The mode of connexion which is necessary to coalescence is total con- nexion. Thus: the connexion of the coalescence is the identity of the whole.” [2], p.226

“To count pin, lens as "2’ is not enough; but to count ’3’ is too much. How, then, can we count pin, lens? The answer is: we cannot count! When we move from compresence into coalescence we can no longer count. The identity of the whole cannot be counted along with pin and lens, for the image is not a new thing but is the coalescence of the pin and the lens in an optical whole. We may perhaps attempt to accommodate this "difficulty" (it is only a difficulty within the framework of our cus- tomary habits of thought and perception) by the adoption of some figurative composite, such as "1 out of 2’, for

> example. However, we should then have the task of discovering the arithmetic of such composites. No matter how tempted we are to make some such compromise, we must resist, for the consequence can only be to obscure the truth: the arithmetic of the whole is non-numerical; the whole is not countable." [2], p.227

> "But language is fundamentally Objective, for language was never the invention (and hence cannot be the tool) of a subject. On the contrary, it is within language itself that the knowing self is crystallized syntactically with its world. We find ourselves (reflexively) in language, the matrix and the medium, not as an origin of reference but as the terminus of disclosure.)" [2], p.228

> "Since thinking, imagining and understanding customarily presuppose compresence, it can only come as a considerable shock to realize that there is no evidence whatsoever for the optical compresence connexion. In particular, it is quite impossible to observe light in the course of propagation–notwithstanding the blind suggestions of our pre-formed imagination." [2], p.230

With these quotes in hand, we appreciate Bortoft's point of view, and how in coalescence there is a disclosure of the whole. Young's experiment can not be completely described because there is no way to reconcile the coalesced absence of distinction of the slits with their compresence in the laboratory. In the next section we shall describe how this ambiguity of One and Two is handled in quantum theory formalism. Since what is observed can be related to compresence, measurements and coalescence, the quantum theory that has come about in relation to the Young's experiment is a mixture of compresence and coalescence. In the next section we make an initial foray into describing aspects of quantum theory and see how this works. Background for this next section can be found in our previous paper [21] and we will carry this investigation of quantum epistemology further in subsequent work. In this author's opinion, Bortoft's mode of holding the part and the whole is deeply relevant to physical understanding.

3 Describing the Double Slit Experiment and Quantum Physics

Henri Bortoft points out that we can describe aspects of the experiment and call them source, screen with slits, observing screen or observer's location. The notion that "something" travels from source to target is without proof and not part of the description of the experiment. When there is one source and two slits but the observer is placed so that the slits can be seen but not distinguished from one another (in the coalescence there is one entity that is either one or two depending upon the point of view) then we cannot make a numerical description since there is one slit and yet there are two slits. We can write this circumstance as a non-numerical coalescence S = {SS}. Remarkably reentry (recursive substitution of the form S into itself.) gives the appearance of an interference pattern. See Figure 3.

S= {SS}
= {{SS}{SS}}
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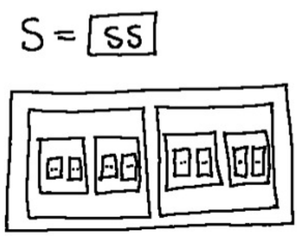

Figure 3: A Form of Reentry for S = SS.

Bortoft makes the point that the experiment cannot be fully described and suggests that the absence of description is related to the (quantum effect) interference and to the recursive interference in the non-numerical description.

Quantum Mechanics takes advantage of the fact that the mathematics can avoid a particular description by using a multiplicity of descriptions.

This going-beyond-number relation is present in the known quantum mathematics.

Suppose there is a complete list of possible states **C1,C2, . . . , Cn**. Using Dirac Notation, we have

$$1 = \sum_{i=1}^{n} |C_i >< C_i|$$

as a decomposition of the identity for a complete listing of intermediate states between <A| and |B>. In the Dirac notation we have

$$<\mathrm{A}|\ |\mathrm{B}> = <\mathrm{A}|\mathrm{B}>$$

The compresence of <A| and |B> becomes the coalescence in <A|B>.

Dirac notation accomplishes a transition between compresence and coalescence in the combination

$$||=|$$

which is a notational affirmation of the identity of Two and One in the form of this transition.

We then have

$$<\mathrm{A}|\mathrm{B}> = <\mathrm{A}|\ |\mathrm{B}> = <\mathrm{A}|1|\mathrm{B}>$$
$$= <\mathrm{A}| \sum_{i=1}^{n} |Ci >< Ci||B >= \sum_{i=1}^{n} < A|Ci >< Ci|\mathrm{B}>$$

A single disclosure <A|B> becomes a multiplicity of possible disclosures via the factorization of the identity into a multiplicity. This arises from the fundamental concurrence: $|| = |$. The summation above is often interpreted as a sum over possible “trajectories” from A to Ci, and from Ci to B, and generalizes to the Feynman Path Integral (sum over histories) of quantum physics. We know that these are not actually trajectories. They are a listing of intermediates in between the initial form A and final form B. What are these intermediate points? We can say that they are "possible measurements that are not performed" but then why should we have to consider them? Why do they influence the outcome?

The intermediates influence the outcome because they are implicit in our description of the coalesence of the experiment. The description of the coalescence is the explanation of the disclosure of the whole.

In quantum theory we speak of measurement. Here we speak of what is disclosed in the terminus of coalescence. What is so disclosed is what is actual, and that is how the whole manifests. As far as the coalescence is concerned, the accuracy of description of the disclosure is the primary issue, not any notion of trajectory, path or history leading to what is the case.

It is convenient to speak of paths from the initial to the final states, as in the Feynman Path Integral. The physicist understands that the collection of paths, whose amplitudes are summed in the Feynman Path Integral, are indications of "possible coalescences", "possible histories". They are not actual, but they constitute the totality of all possible descriptions of a process. There can be a confusion in using the words trajectory, path or history for such structural possibilities and the physicist, using quantum mechanics, learns to discriminate between possibility and actuality just as we are here learning to discriminate between compresence and coalescence.

We know from quantum practice that these virtual stopping places or virtual trajectories do influence the results of the experiment. Once we accept the idea of a source and a target, then the possibility of intermediate sources and intermediate targets can be considered. Quantum mechanics takes the place of direct description by making a multiplicity of descriptions.

Consider now the double slit experiment. We have the Source $\langle A|$ and the Target $|B\rangle$. The two slits can be labeled C1 and C2 and the amplitude is the sum

$$\langle A|B\rangle = \langle A|C1\rangle\langle C1|B\rangle + \langle A|C2\rangle\langle C2|B\rangle$$

We can regard the coalescence disclosure of the experiment in the form $\langle A|C|B\rangle$ where source is seen through indistinguishable slit(s) C and the target B is the terminus of disclosure.

In Bortoft's language we would write C = {CC} to denote the numerical reentry or ambiguity of One and Two. In quantum formalism we write

$$1 = |C1\rangle\langle C1| + |C2\rangle\langle C2|$$

to denote the totality of the two slits as intermediate placements. This equation is the quantum version of an entity that is "One" and yet it is "Two". The reentry language does not know anything about compresence or metric. The quantum description is an amalgam of coalescence and compresence. When fully articulated the quantum formulation takes into account the metric and connection features that make up the coalescence and so allows a particularly detailed account of the interference pattern in relation to the placement of the target and the slits. The quantum version does not use the concept of trajectory or make any assumption that there are particles or photons traveling along particular paths from source to target. The slits C1 and C2 are described as in the intermediate distance between source and target. It is understood that the slits can participate in a coalescence and that there are states of coalescence where the slits are not distinguishable from one another. The two indications $\langle A|C1\rangle\langle C1|B\rangle$ and $\langle A|C2\rangle\langle C2|B\rangle$ are not trajectories. They are two possible descriptions of the coalescence, neither complete at the point where the slits are not distinguishable. We take each description in turn, calculate an amplitude for it and add the amplitudes to obtain the quantum amplitude. The quantum model gives a prescription for dealing with multiplicities of descriptions (often thought of as possibilities) and a rule involving complex numbers for combining them to obtain an evaluation. It is a miracle that this scheme gives good results in relation to experiment.

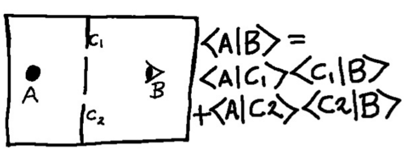

Figure 4: The Superposition of Descriptions in Young's Experiment

To see the power and simplicity of this quantum formalism consider the quantum description and treatment of entanglement. In entanglement we are given a doubled terminus of disclosure. One terminus is in Chicago and the other is in New York. The state of coalescence is of the form {CN} where only C is visible in Chicago and only N is visible in New York. We are told that C and N are entangled in the sense that each will reveal either 0 or 1 but if C reveals 0 then N must reveal 1 and if C reveals 1 then N must reveal 0. The quantum mechanical language consists in a superposition of descriptions $|CN> = |01> + |10>$. If the Chicago terminus is examined and 0 is found then the state becomes $|N> = |1>$ while if the Chicago terminus is examined and 1 is found then the state becomes $|N> = |0>$. Since no signals or trajectories are involved, the distance between New York and Chicago is not relevant to these circumstances. This description points out that a disclosure can, in the presence of some knowledge, make certain the result of another distinct disclosure. If we did not already know about the apparently random or unpredictable nature of certain quantum phenomena, this entanglement situation would appear to violate the dictum that information cannot be obtained at rates faster than the speed of light. But since it is an experimental finding in quantum realms that to observe 0 or 1 in such a structure is not predictable, we cannot use entanglement to send messages at faster than light speed.

From this we see that the unpredictable or random nature of quantum theory is a consequence of the physics of special relativity wherein it is understood that information cannot be transmitted beyond the speed of light. How this property of relativity is related to description, compresence and coalescence will be the subject of another paper.

We see, in this brief introduction to the relationship between Bortoft's concept of the whole and the nature of description, that his views are in line with the structure of quantum theory and that the project of examining this alignment in greater depth is worthwhile both for the philosophy of the whole and for the understanding of basic physics.

4 Optical Qualia and the Penrose Triangle

In this last section we suggest an optical experiment analogous to the double slit experiment in the form of the Penrose Triangle [30]. See Figure 5. There are three vertices in the Penrose Triangle, and we perceive a plausible and yet impossible (impossible to exist embedded in our common three dimensional space) entity. We can think of this entity, impossible to describe and yet experienced by us optically, as a coalesence disclosed before us.

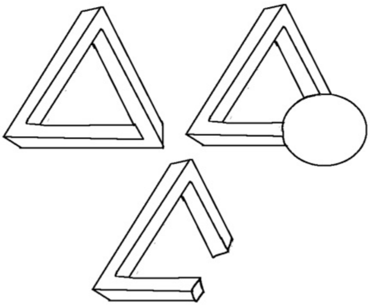

Figure 5: Penrose Triangle and Compresence and Analogy with Young's Experiment

Just as the interference pattern in the Young's Experiment will disappear if one of the slits is occluded we find that if one of the vertices of the Penrose Triangle is occluded, then the form of the Penrose Triangle is replaced by a realistic depiction of beams meeting at 90 degrees with no possibility of a third vertex. The occluded vertex is seen as imaginary in our compresent reconstruction and actual in the coalescence of the original Penrose Triangle.

The analogy of this discussion of the Penrose Triangle with Bortoft's analysis of the Young's experiment is very strong. The whole that is the Penrose Triangle exists only in its condition of coalescence, and in that condition the imaginary whole is disclosed. In the form of coalescence only the imaginary is real.

References

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