The Half-Silvered Mirror Experiment

1. Introduction

The fundamental elements presented in the Impressionist Theory of Everything (IToE) are:

1. Paradox is a systemic mechanism in the universe the legitimacy of which can be justified by reference to a diverse collection of theoretic and empirically-based arguments. This paradox appears in two possible formats that both refer to the presence of absolute boundaries. In whatever form they take, these boundaries are infinities. The structures so described cannot be rationally contained in any single observational perspective and this is the source of paradox.

2. A mathematical and geometric model is derived from analysis of the consequences that are naturally inferred by the presence of paradox. This concept is then extended to describe how nonresolvable paradox results in an accumulating space of changing shape over successive cycles.

3. The force described by IToE is based on a principle of conservation. Specifically, a dimensional boundary exists between two absolutely separate dimensional levels (subclassical and classical). Across this boundary, toward the classical, possibility increases. In order that the distinction between the two levels is conserved, the event structure at the subclassical (quantum-mechanical) level must be simpler. After some process of evolution occurs, the result is a structure that has a classical signature for its dimensional complexity. In this domain the potential for real location or possibility is greater.

4. Observation is only possible in a domain that is classically defined for its dimensional complexity. In this state, paradox produces an ongoing cycle of accumulation that is the

attempt of a system to resolve the systemic presence of fundamental paradox. The result is that a process of cycle ensues by which dimensional complexity is subsumed into the continuously developing structure. This accumulation takes as different form in each phenomenon studied, but the generic process is the same.

2. The geometry and mathematics of the half-silvered mirror experiment

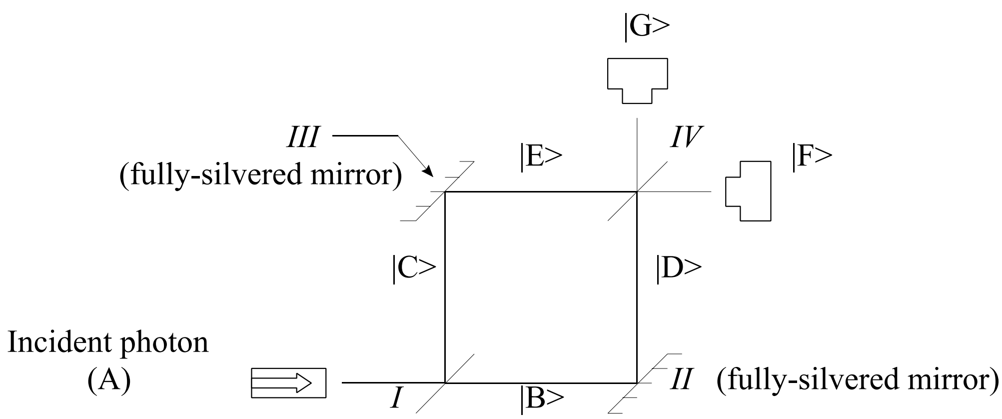

Figure 1. Illustration of the half-silvered mirror experiment. Half-silvered mirrors are found at *I* and *IV*. Fully-silvered mirrors are at *II* and *III*. In IToE, this structure is called a *space*. Two domains of property are housed, one quantum mechanical and the other classical. Their frameworks are joined by paradox.

The structure in Figure 1 represents the half-silvered mirror experiment. This experiment provides the simplest of empirical frameworks for discussing the application of the concepts of (IToE).[1] The half-silvered mirror experiment consists of an apparatus for firing photons and a two-path structure that is created by a half-silvered mirror. The routes shown in Figure 1 are stated in ket notation which specifies that the vectors (state vectors) are quantum mechanical. This ket notation is removed when the path structure is composed at the classical level (Figure

[1] For a full discussion of the experiment and the mathematics that apply, see Penrose (1989), Chapter 6, and Penrose (1994) chapter 5.

2).

These routes and their parts are defined in a two-dimensional framework that can be called a space. The photon's internal structure is closed when this space is classically defined, and the photon's internal structure is open when it is quantum-mechanically defined. These are the two frames of reference for the passage of a photon across the structure in Figure 1. If the paths, in their quantum-mechanical format, are disturbed by observation, then the state collapses to its classical form.

2.1 The classical description

The classical description of the half-silvered mirror experiment contains two real paths that have an 'or' relationship for the passage of a single photon. These alternative structures of path are [(B) to (D)] and [(C) to (E)]. Note: Figures 2 and 3 show the same framework as in Figure 1 except that the illustrations has been rotated 45 degrees so that they are oriented vertically to these planes.

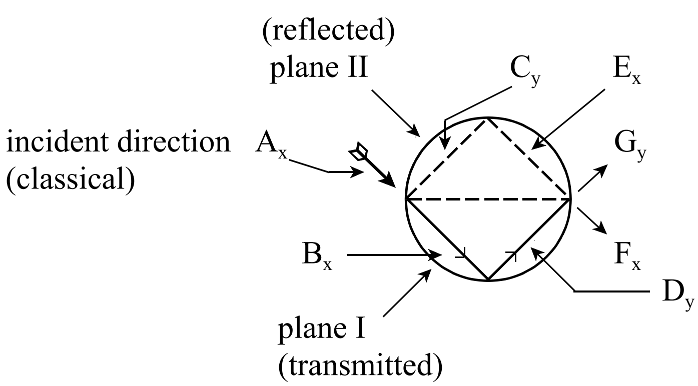

Figure 2. Classical representation. There are two potentially real paths. The solid lines indicate one that is actually observed. This is a factor of chance. The dotted lines represent the other path which has equal probability of forming the path of the photon in some future event.

The first set of paths is plane I. It consists of two paths in series at 90 degrees. Exit for any photon that travels this structure is in one of two directions (F or G). The second set of paths is plane II which has the same series arrangement as plane I. Again, exit for a photon on this set of paths is one of the two directions (F or G). The relationship of planes is I '*or*' II.

The classical format for construction of the paths in the half-silvered mirror experiment is straightforward. It is rational and intuitive because it is what we expect in our classical experience. For example, the plane consisting of paths [(B) + (D)] is one of two rational routes across the space of Figure 1. This series of paths passes across the full mirror at *II*. The other rationally composed route is (C) + (E) which passes across the full mirror at *III*. If observation occurs within this space of paths, the space is found to contain two probabilistic alternatives of route for a single photon. The photon is always found on one of them. Little discussion is required to validate this assertion since it is obvious from our everyday experience of similar situations. The rationalism for the classical path across mirror *II* is represented as

$$B_x + D_y \quad \rightarrow \quad F_x \text{ or } G_y \tag{2.1}$$

Subscripts *x* and *y* refer to the orthogonal directions in the space relative to incident A.

The plane for passage across mirror *II* is a additive series of directions. The identities of the paths are established by their values, which are each understood to be (1), and accordingly, each part of the total route is a whole and instantaneous location for evolution of the action that crosses the space.

The quantum-mechanical version of the space in Figure 1 uses the same designation of paths but is written differently because of the strange characteristic of superposition found in quantum-mechanical structures. The relationship of superposed states for the passage of a single photon is an '*and*' construction.

The nonimaginary set of paths (state vectors), in Figure 3, is [|B> to −|E>] (at 180 degrees). This is a combination of planes I and II. The second set of paths, which is imaginary is [*i*|C> to *i*|D>] (at 180 degrees). This is also a combination of planes I and II. Exit is not based on classical probabilities since the photon is only found in the direction |F> . The direction |G> cancels. The structure of classical probability cannot represent this process.

$$[\ i\,(|G\rangle - |G\rangle) + (-2|F\rangle)\ ] = -2|F\rangle \tag{3.1}$$

(full mathematical description below)

2.2 The quantum-mechanical description

The fact that the two structures for the same space (classical and subclassical or quantum-mechanical) have inconsistent properties leads to the unavoidable conclusion that the spaces are not the same space, even though they are contained in exactly the same domain. This is also the salient feature of the Russell paradox. The situation is made more perplexing because the mechanism that causes one or the other description to prevail is to simply <u>observe</u> or <u>not observe</u> the interior of the common domain displayed in Figure 1.

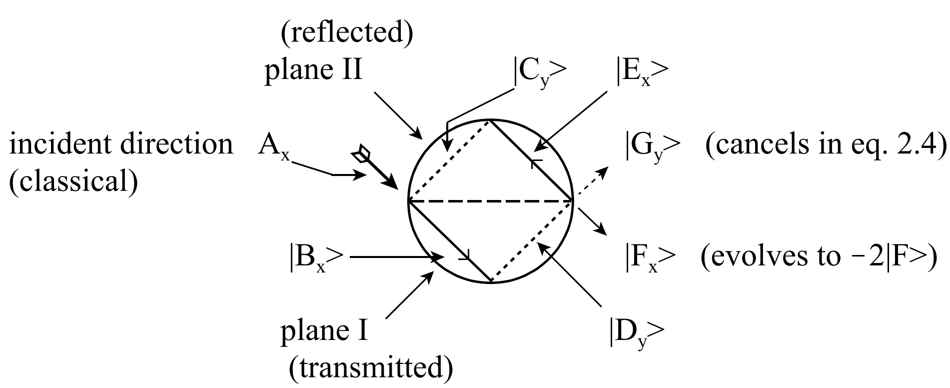

Figure 3. The Quantum-mechanical format: We now find a potential of only one path of exit for a photon that crosses this structure. Only a single (unitary) state is required to fill the space. The additive relationship of paths, previously a property of plane I or II , is now the property of state vectors across planes I and II. The state evolves as a linear superposition of the previously alternative routes.

When the above space is not observed, a quantum mechanical description applies. By not observing, the observer has not forced raising of the state to the classical level in which the observer has membership. As discussed above and in Section 1 of this web site, under IToE, the quantum mechanical or subclassical space is fundamentally simpler for its complete composition.

The quantum-mechanical structure in Figure 2 does not represent just one space, but rather two. There are two infinities for potential path displayed, one nonimaginary and one imaginary. Neither the nonimaginary nor the imaginary structures of paths are observable. Each is missing some element that is required for the phenomenon of observation and that which is missing, in each, is complementary to the other set of paths. It is the dimensional nature of the space in Figure 1 that determines whether we find two rational paths in a singular and classical space (classical) or one nonimaginary plane and one imaginary plane in two spaces that are not members of themselves. The nonimaginary plane is still not real since it is fractured at 180 degrees across planes I and II. For discussion of the nature of paradox and complementarity across mathematical structures of the two-dimensional plane, see Chapter 1.3, Two Mathematical Spaces, One Roof: The Local and Nonlocal Structures of the Unit Circle.

3. Due dominance

In no other situation does the act of observation have such a destructive effect on the rationality of any process. Under the Impressionist Theory of Everything (IToE), a new mechanism is described that is responsible for the rationally unaccountable relationship between the quantum-mechanical and classical states. This mechanism is the conservation of potential across fundamentally different dimensional constructions.

In brief description of this concept, the classical alternatives of route must be hidden at the subclassical level so that the dimensional complexity of the two spaces (subclassical and classical is respected). If we were to find classical alternative displayed at the subclassical level or quantum-mechanical nonalternative displayed at the classical level then the appropriate degree of freedom at each of these levels of dimension would be violated. This concept is explained fully in Chapter 1.5, The Cross-Dimensional Development of Angularity.

At each level of dimension, unitary (in the quantum-mechanical state) and probabilistic (in the classical state), these structures of possibility protect the appropriate level of dominance for conclusion. In the half-silvered mirror experiment, *Dominance for conclusion* is determined by two factors that are whether we can observe a photon on an individual path within the structure and whether we observe one or two possible routes of exit.

4. The mathematical description of the subclassical space

The unitary evolution of the quantum mechanical state is indicated in Equations (4.2) to (4.6) using ket notation. We see that in the nonimaginary portion of the structure direction is both forward (+ for |B>) and backward (− for |E>). These signs indicate direction in time, and because of the opposite signs we cannot state that time flows in the classical sense . Note: $i \times i = -1$.

$$\text{If } a > 0, \quad \sqrt{-a} = i\sqrt{a}; \quad i^2 = -1 \tag{4.1}$$

$$A \rightarrow |B\rangle + i|C\rangle \tag{4.2}$$

$$|B\rangle + i|C\rangle \rightarrow i|D\rangle + i\, i\, |E\rangle \tag{4.3}$$

$$i|D\rangle - |E\rangle \rightarrow [\ i|G\rangle - |F\rangle\ ] + [\ -i|G\rangle - |F\rangle\ ] \tag{4.4}$$

$$= (-2|F\rangle) + i(|G\rangle - |G\rangle) \tag{4.5}$$

$$= -2|F\rangle \tag{4.6}$$

4.1. The dichotomy of singular and dualistic elements in the quantum mechanical format

The main premise of IToE is that, for the proper inclusion of all structure that defines any state fully, we must account for a dichotomy of singular and dualistic elements. The singular or unitary description is as found in the quantum mechanical format.

The photon at *IV* always takes the route |F>. The state −2|F> describes the unitary photon, at the classical level, using formalism that distinguishes the evolution of its subclassical state. Once the photon has exited at |F> in Illustration 1, the path structure has been properly reclosed in classical terms without disturbance, as long as no internal observation occurs. The factor of −2 arises because the half-silvered mirrors and their two-path structure have <u>opened</u> the hidden subclassical structure of the photon. Each path contains one half of the classical structure of the photon. Therefore, two paths are required for the classical structure to be complete.

Although the interior space of the photon has been opened and reclosed, there are no observational consequences because the dualism at the subclassical level has remained nonobserved. By contrast, if the observer enters this nonobservable and subclassical space, the legitimacy of what is fundamental has been violated and is not conserved unless dimensional change occurs. Consequently the subclassical dualism collapses to a classical dualism.

Neither of the nonimaginary parts of the space of the structure in Figure 1, |B> and −|E>, individually contain sufficient dimensional development to be classical. For this reason, even though the space is opened by the apparatus, it remains unitary provided it is not observed. Any contact of the subclassical interior with the classical domain of the observer, by observation or outright obstruction, means that the parts must be raised to the classical level. Only then are the separate potentials of the two states conserved.

This process of collapse is an inherently a dimensional transformation. It is not simply a matter of a mechanical disturbance of a finely (microscopically) balanced and purely observable state. The hiding of the dualism <u>conserves</u> the legitimate <u>fundamental</u> nature of the photon in the space of the observer. When the observer opens the interior of the photon for any of its properties (through the apparatus of the experiment), these properties must remain unitary. This is the same as stating that the parts must be nonlocal. For the above reasoning, use of the term *microscopic*, to identify any subclassical state, is inappropriate.

5. Property is reversed across the parts

The domain of the half-silvered mirror experiment contains, on one hand, a unitary state (all its parts contained by a single event) and on the other hand, a dualistic state (all its parts are not singularly contained by a single event). The terms that apply are *containment* and *noncontainment*. The first is quantum-mechanical and the second is classical.

The relationship of contained and noncontained structures in a common domain is exactly represented in linguistic terms by the Russell set which is *the set of all sets that are not members of themselves* (see Chapter 1.2, The Paradoxical Reversal of Property in Three Theoretic Structures). In the half-silvered mirror experiment the mechanism across the two constructions is the reversal of property for path.

There has been a reordering of what is continuous between the classical and quantum mechanical versions of the overall space. Continuous path is composed in series in the classical version, and it is composed in parallel in the quantum mechanical version. The paths |B> to |E> (at 180 degrees) are continuous (although not so in the classical sense). Planes I and II each form separate lower dimensional spaces housed in a common domain.!

6. The conservation of potential

The conservation of potential between the subclassical and classical states requires that when the subclassical state is entered its potential for the display of possibility increases. This principle of conservation explains the strange process of instantaneous linking between remote locations in the classical domain when they are composed subclassically. The nonlocal linkage between sites indicates that conservation of the potential of the photon, to fill the given state, remains subclassical. When collapse occurs the state is displayed in a more complex format.

If this process of collapse were not instantaneous, then the state of the photon (as whole) would exist in a nonconserved condition for the period of time that was required to communicate the information it should collapse. This is the reason that this form of change in space-time does not obey classical law of physics that communication cannot exceed the speed of light. The quantum mechanical state in the half-silvered mirror experiment must instantaneously inflate under observation of its interior.

This inflationary process is the evolution of the state *R* that is defined in Chapter 1.1, The Frame of Reference for the Impressionist Theory of Everything. In brief, *R* is the term defining the evolution of a paradoxical condition. A cycle results that is not resolvable and as this cycle proceeds, dimensional structure and complexity is subsumed into the domain of *R*. Thus, *R* exerts a pressure on the state of a dynamic system that is only resolved at some absolute boundary of accumulation.

7. The inflationary structure across the cycle of half-phases

For the evolution of the state described in Equations (4.2) through (4.6) and Figure 3, the photon, as it exists, is found in the direction described quantum mechanically as −2|F>. The factor (2) appears because the structure of the unitary photon, which is fundamental in the space of the observer, is represented in its subclassical format. The added complexity at the subclassical level requires that more parts be accounted for than in description at the equivalent classical level.

The full structure of (A) for half-phases at the quantum mechanical level is

$$(A) = (-2|F\rangle) + i(|G\rangle - |G\rangle). \quad (7.1)$$

The half-phase $i(|G\rangle - |G\rangle)$ is cancelled and is not observed because of the opposite signs and because it is imaginary to the phase of the observer. The portion $i(|G\rangle - |G\rangle)$ is not a classical alternative, but rather a paradoxical structure that is absolutely noncontained for the observational perspective of the observer. See Chapter 1.3, Two Mathematical Spaces, One

Roof: The Local and Nonlocal Structures of the Two-Dimensional Plane, for the discussion of how this structure for the route |G> is a paradoxical space containing the complementary perspectives of paradox $\sqrt{1}$ and $\sqrt{-1}$.

The imaginary portion of each half-cycle is a one-quarter-phase shift. This is across 90 degrees which explains why the two directions are mutually imaginary. Specifically, the ortho structure of subclassical space is defined across 180 degrees not 90 degrees.

7.1. At the subclassical level

On each cycle across the half-phases, the imaginary portion inflates, or is subsumed, into the nonimaginary portion. The result is that the inflationary portion of the structure is never a factor in what is observed unless the observer enters the sequence of these parts. This relationship of inflationary and emergent half-phases, on multiple firings of a photon, is represented schematically in Illustration 1. On random firings of the photon, the route of the half-phase i|G> always collapses into |F>.

	cycle①			cycle②			cycle③		
	½	½		½	½		½	½	
	[i|G>→	|F>]	+	[i|G> →	|F>]	+	[i|G> →	|F>]	. . .
observed phase		↑			↑			↑	. . .

Illustration 1. The nonobserved half-phases are shown for the firing of single photons. The imaginary half-phase always inflates into the nonimaginary half-phase.

7.2. At the classical level

At the classical level, the observer has disruptively entered the half-phase structure. The timing of this entry is random over the primordial and superposed cycle of the state. Also see Chapter 1.5, The Cross-Dimensional Development of Angularity and Chapter 1.6, Primordial

Cycle for discussion of the factors in primordial cycle. The result is that, in probabilistic terms, either half-phase can form the emergent classical state as the other half-phase collapses and becomes hidden (dimensionally subsumed). This process explains why the path of exit is probabilistically either (F) or (G) when the structure is classical.

cycle① cycle② cycle③

½ ½ ½ ½ ½ ½

[*i*|G>→ |F>] + [*i*|G> → |F>] + [*i*|G> → |F>] + . . .

observed phase ↑ ↑ ↑ . . .

randomly determined at the classical level

Illustration 2. When the half-phases are opened by the observer, collapse can occur into either. This is a random process depending on the precise time of observation relative to the primordial superposed cycle. The classical result is that the photon takes either route (G) or route (F).

8. Containment and noncontainment of *R*

The last point in the discussion of the half-silvered mirror experiment is to draw attention, once more, to the important concept of the relationship between containment and noncontainment for the dichotomy of singular and dualistic structures. In the frame of reference in which the photon is not disrupted (or observed) as it travels across the apparatus in Illustration 1, the paradoxical dualism of *R* is contained subclassically. The state represents a singularism to the classical observer because the photon is able to entirely fill the space of the apparatus through linear and parallel superposition across it.

The second frame of reference in which to specify the singularism and dualism is when the dualism is formed at the classical level. In this case, the full dualism of *R* is not contained in a single event. The singularism is again the observed photon and the dualism is displayed statistically in a probabilistic event structure. These two frames of reference, for specification of dualism (subclassical and classical), are paradoxical for their properties.

9. Conclusion

The Impressionist Theory of Everything has been applied to explain the mysterious action found in the EPR-type structure of the half-silvered mirror experiment. EPR-type structures allow the singularism and dualism defined under IToE to be opened in a common structure and the paradoxical mechanism between them to be examined. In order that the photon fills the probabilistic structure of the half-silvered mirror singularly the space of the apparatus is dimensionally reduced, and accordingly, the internal space of the photon is opened. The term applied is that the photon is *nonlocal*. The nonlocal description for inclusion of the dualism remains intact as long as the observer does not force the photon back to its classical format by observation. Prohibition of observation is absolutely necessary if the complexity of the photon, in its subclassical format, is to be conserved.

The relationship of the subclassical and classical states in the half-silvered mirror experiment is that property is reversed across the common set of paths that form these states. The two spaces of the half-silvered mirror experiment represent, in a static format, the evolution of complexity for *R*, the Russell set object.

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REFERENCES

1. Penrose, Roger. 1991. The Emperor's New Mind, New York: Penguin Books.

2. Penrose, Roger. 1994. Shadows of the Mind, Oxford: Oxford University Press.

