



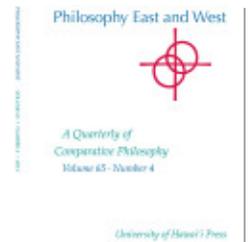
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FINDING LIGHT



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Parts of the natural sciences have been deepened to the point where evidence can be brought to bear in a controlled way on problems classified as metaphysical.

Abner Shimony¹

According to Elizabeth Napper, *śūnyatā* inheres in “the utter unfindability of objects” owing to their intrinsic emptiness: “If things existed in the palpable, independent way we imagine them to, they would have to be such that they could be found when sought—but they cannot.” She further notes that when objects are subjected to meditative analysis “they disappear altogether,” and “one is left with the absence of what was sought, with a mere vacuity that is emptiness.”²

This definition of *śūnyatā* originates with Nāgārjuna, who insisted that causes, parts, and an apprehensible nature (a nature that is amenable to apprehension—at least seemingly so) mark an object as empty.³ Because these characteristics constitute objects as we know them, objects cannot be said to exist in their own right. Hence the intrinsic emptiness and consequent unfindability of a pencil, say. We cannot find it apart from its parts, causes, and apprehensible nature.⁴

In the present article, I argue that physical light—the light that science investigates and the agency by which we see the world—is an exception to Nāgārjuna’s declaration. That is, I wish to show that light exists without parts, causes, and an apprehensible nature. Put differently, though we may attribute these characteristics to light, that attribution attenuates with further consideration until light is seen as “its own thing.” In developing this argument, however, I ultimately embrace rather than reject Nāgārjuna’s pronouncement. Light, I believe, is a deeper expression of emptiness than that revealed in the unfindability of material objects. To study light is to approach the moment at which the bottom falls out of the bucket.⁵

The article consists of three parts. In the first, I propose that light cannot be found in any straightforward sense because it exists and moves in ways that break the frame of our everyday understandings of reality. Not only that, but light is beyond the reach of vision and visualization: it lacks an apprehensible nature. In the second part, I build on the previous analysis by suggesting that light also lacks parts and causes; that is, it is difficult to compare light to material bodies, which most certainly do arise by virtue of parts and causes, at least in a conventional, non-ultimate sense. Finally, in the third part, I offer an analysis that demonstrates that parts of light (photons) intrinsically lack the resources to produce a world that corresponds to the conventional view that reality consists of separate part-like things. That is, even if light comes

in part-like pieces, it would not be able to give us a part-filled world—a world of independently existing objects.

This demonstration, I argue, is interesting in two ways: (1) it affirms the Buddhist point that material reality cannot be reduced to separately real, part-like things, and (2) it parallels the scientific realization of quantum entanglement wherein particles in a twin state (particles originating from a common event) remain timelessly interactive regardless of spatial separation. Along the way—that is, throughout the article—we catch glimpses of light's *śūnyatā*-like nature and its consequent capacity to engender emptiness or unfindability from its own unfindability.

Ultimate Reality: Three Tests

En route to a more detailed analysis of light with respect to Nāgārjuna's claim regarding the unfindability of things, I begin with two definitions. (1) To say that light is empty of parts and causes is to propose that it stands by itself as a thing in the world: it possesses its own metric and thereby bears no relation to other things in the world. (2) To say that it has a non-apprehensible nature amounts to saying that it is intrinsically invisible and conceptually elusive.

In speaking of "luminous emptiness," Francesca Fremantle writes, "As an elemental force in the universe, fire is equivalent to light, and we actually experience it more in the form of light than of heat."⁶ Without fire, whether the fire of the sun and stars or terrestrial fire, humans would not know light, and light is one of the deepest mysteries of modern science. Here I touch on one aspect of that mystery to suggest what ultimate reality might look like from a Mahāyāna Buddhist perspective. First, we would have something that does not depend on other things for its existence. Second, we would not be able intellectually to arrest that something: it would stay in play—in process—despite our best efforts to nail it down conceptually. And third, it would lack intrinsic self or essence. Better said, its essence would be emptiness. Let us mark these three criteria—ontological independence or freedom from other things, conceptual elusiveness, and self-emptiness or non-self—as the three tests of ultimate reality.

In the early nineteenth century, scientists demonstrated that light is a wave phenomenon. When they directed a beam of light toward a two-slitted diaphragm, it produced a wave-interference pattern on a backdrop opposite the diaphragm (see figure). This was surprising because at the time scientists believed that light consisted of particles, in which case particles would cluster in two shot groups roughly opposite the slits. No one could, of course, see the light as it propagated through space, but the interference pattern implied that as light emerged from the two slits it spread out in wave-like fashion and began to self-interfere. When the two emerging waves met in phase (crest meeting crest), constructive interference occurred, as evidenced by the light bands of the interference pattern. The dark bands were explained as instances of destructive interference—the waves meeting out of phase (crest meeting trough).

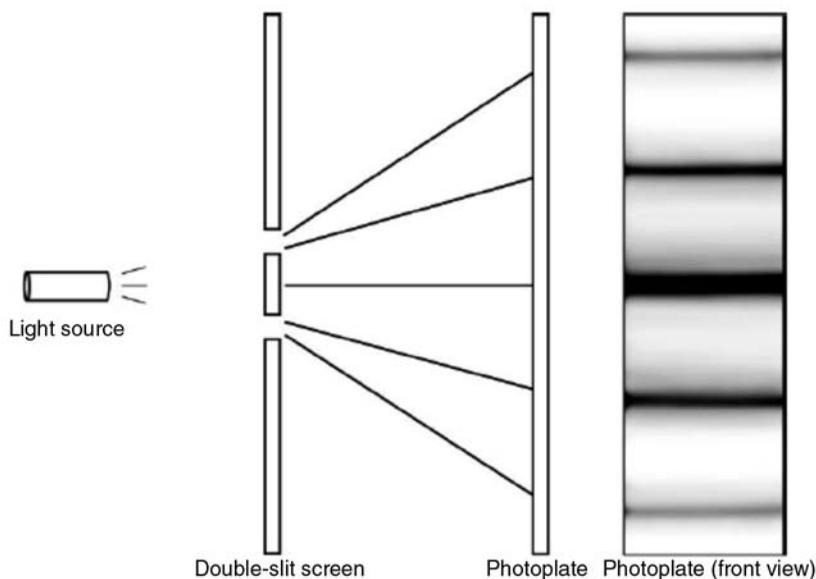


Figure 1. Light is directed toward a two-slit barrier and then blocked by a backdrop, which in this case is a photoplate or light-sensitive film. If light consists of particles, two particle clusters should show up opposite the slits. Instead an interference pattern registers, signifying the wave nature of light.

This is the classic double-slit experiment. A century later it would be refined to demonstrate wave-particle duality. Early on, however, it merely disclosed light's wave nature, and the clear implication of this disclosure was that light requires a medium for its propagation through space. Waves cannot travel—cannot even exist—without a supporting medium because they are nothing more than vibrations of the medium. Sound waves, for example, occur only as air (or some other material medium) vibrates or undulates. Similarly, water waves are nothing in and of themselves, but merely the wave action of water. And light, it would seem, should follow this pattern: being a wave it would exist only by the grace of a medium. It would, in fact, be nothing more than the undulations of that medium. To suggest otherwise was tantamount to proposing that water waves could exist without water.

Pictured this way, light, being fully dependent on something else, would not qualify as ultimate reality. But as the nineteenth century wore on, the medium thought to support light proved to be elusive. Theorists worked hard to pin down its properties, the mix of which was unlike any known substance. While the medium—called the universal ether—was deemed extremely subtle (though material), it was also said to be incredibly rigid (perhaps a million times more rigid than steel). The first property helped explain our inability to detect the ether under normal circumstances, while the second implicitly acknowledged the tremendous speed of light: only an extraordinarily rigid substance could undulate so quickly. But aside from the difficulties associated with imagining the ether's properties, there was the bigger issue of its experimental non-detection. A series of experiments performed in the latter part

of the century failed to establish the ether's existence, an almost unthinkable result given light's supposed dependency on a propagating medium.

Into this quandary came the young Albert Einstein, who rejected the ether as a "superfluous" (*überflüssig*) notion.⁷ That rejection deprived light of its medium, which, conceptually speaking, could not be disassociated from the prevailing understanding of light as a wave phenomenon. From a Mahayanist perspective, however, it might be said that light, in having been set free from its medium, exists on its own. It thus has passed the first test of ultimate reality: as a wave light does not depend on a substratum. As Arthur Zajonc puts it: "The nature of light cannot be reduced to matter or its motions; it is its own thing."⁸

Zajonc's point that light cannot be reduced to matter registers once we realize that it undulates without the support of a material medium. His additional point that it cannot be reduced to the motions of matter—the familiar motions of everyday material bodies—registers upon grasping Einstein's insight that the speed of light is the same for all observers, no matter how differently they may be moving. Except for light, speed is always a variable and relative quantity because the measured speed of one thing partly depends on the speed of the person or thing executing the measurement. A person running at six miles per hour relative to the surface of the earth will be measured at two miles per hour by a person walking at four miles an hour in the same direction; or at twelve miles per hour by a third person running in the opposite direction, if that person is also moving at six miles per hour. Though most of the time we relate all speeds to the surface of the earth so as to standardize our measurements, this is merely a convention. The earth, after all, is also a moving body, and one whose speed is therefore partly dependent on the state of motion of the person performing the measurement. To a person standing on the earth it is at rest, but if someone could observe the earth from the sun, she would see it gliding along at about eighteen miles per second.

This is the stuff of everyday experience, and even if we do not worry about it much, we may readily appreciate how strange it would be to find something whose speed is absolutely invariant across all perspectives; something whose speed is independent of its measurer's state of motion.⁹ Light is that something. Not only does it not depend on a material medium for its existence, but its speed is also "its own thing," free from the speeds of material bodies. A space traveler moving at 99 percent the speed of light (relative to the surface of the earth, say) will always measure light at its characteristic rate of 186,000 miles per second, regardless of what his direction of travel may be.

In brief, no motion or maneuver on our part can alter the speed of light. Light is, as Zajonc insists, irreducible "to matter or its motions." When Einstein dismissed the ether, he freed light from the universal substratum that putatively supported its motion through space. He also made the speed of light constant across all perspectives. Both of these conceptual adjustments are now regarded as scientific fact—never mind that neither makes sense from the standpoint of everyday experience. Evoking our wonder, light seems to have an integrity or metric of its own, one that cannot be scaled into our familiar understandings about the world. It is "its own thing," a fact

that allows it to exceed or stay ahead of the ideas one musters up to understand it. Here one recalls Nāgārjuna's claim that *śūnyatā* entails "the relinquishing of all views,"¹⁰ or, as David Loy translates the phrase, "the exhaustion of all theories."¹¹

Harking back to old traditions that associate light with truth, I suggest that as the very coin of understanding, light cannot be traded against itself: thus it always stays in play. According to Einstein, we cannot overtake a light beam; indeed we cannot, in the least, reduce its speed by trying to overtake it. This deeply counterintuitive fact marks our parallel inability to intellectually arrest light, to put it out of play as a source of wonderment. If this judgment is correct, light passes the second test of ultimate reality: it stays in process, never lapsing into conceptual stasis.

The third test entails emptiness, and light proves to be empty in a way that is both obvious and unseen. It does not show up on its own. Try shining a flashlight skyward on a dark night. Unless there are foreign objects in the air—dust particles or raindrops, say—one sees nothing at all. Light does not announce itself; it shows up only as it graciously announces other things.¹² It is an emptiness waiting to be filled; that is, waiting to receive something that it can illuminate. If indeed we could see it on its own, it follows we would see nothing else. What, after all, is closer to the eye than light; if it were to visually announce itself, we would be wrapped in a cocoon of light—light would be our blindfold. Instead, we are visually situated in the unbounded expanse of light's self-emptiness and can therefore see things millions of miles distant. By not seeing light *per se*, we see to the farthest reaches of the universe.

Simply put, light drops out of sight to give us sight.¹³ Einstein said the speed of light in a vacuum is always—for anyone who cares to measure it—186,000 miles per second. The strange thing about this proposition is that we get no hint of light's existence upon looking into a vacuum, even after shining light therein. With nothing to illuminate, it does not register as light. It coexists comfortably with the nothingness of the vacuum. From all appearances, it falls into the void without protest. But then let something else (a speck of dust, say) fall into that void, and bright disclosure immediately occurs. The disclosure lets us know the vacuum is light-filled, but we would never know that otherwise, for light is the one thing that can fill a vacuum without adding to the vacuum's emptiness.¹⁴

Trying to sum things up, we might say that light is empty in the sense that it is unmindful of its own reality, but graciously mindful, and consequently revelatory, of the reality of other things. It is content to exist in darkness or obscurity—to exist not at all, from all appearances—but keen to rescue other things from such a fate. If these propositions anthropomorphize light, that characterization coincides with the Buddhist belief that *śūnyatā* is a principle of generosity and compassion. "Emptiness and compassion are completely intertwined," writes Fremantle.¹⁵ Lack of self opens the world, gives us "absolute sensitivity, unbiased love, and limitless concern for everything in existence"¹⁶ whereby we become "unbounded portions of the whole."¹⁷

How does this happen? Buddhism's first noble truth is that suffering is universal. It is something we all share and therefore something that knits us together, affords us universal intimacy, despite the illusion of individual apartness. As we grow out of this illusion—the misapprehension that *I* alone have a monopoly on the problems

of life—we discover ourselves in others, which means we are swelled or expanded beyond the myopic concerns of individuality. Pain—my pain—thus blossoms into compassion for all beings, every one of which is *me* by reason of shared initiation into the hurtfulness, and goodness, of existence. “For each of us,” writes Pema Chödrön, “sorrow has exactly the same taste; for each of us rage and jealousy, envy, and addictive craving have exactly the same taste. And so it is with gratitude and kindness.”¹⁸ At an elemental level, we are each other.¹⁹

By instantiating this elemental interchange of being, light gives a world in which relations among things are “criss-crossing to infinity.”²⁰ That world is both expansive and point-like owing to light’s self-emptiness and its consequent capacity to be “a single thing with the universe inside.”²¹ Let me try to explain.

Parts and Causes

We return to Nāgārjuna’s claim that things having parts, causes, and an apprehensible nature cannot be real. I have tried to show that light lacks an apprehensible nature: it cannot be reduced to “matter or its motions”; nor can it be seen as light *per se*, though its intrinsic invisibility enables the seeing of other things. I have also noted that modern science allows that, unlike other kinds of waves, light waves exist without a material medium—an allowance which might prompt the inference that light exists without parts and causes. But that would be a careless inference if it were not buttressed by the additional evidence which I now introduce. Thanks to the contemporary realization that light manifests itself differently in different circumstances, we know that light is both wave-like and particle-like. Light particles are called photons, and they are deemed atomistic or indivisible. Given this understanding, we readily imagine photons as the fundamental parts of light, and further imagine that each is a distinct or independently existing unit. Given the elusive nature of photons, however, this supposition is hard to forthrightly maintain. George Greenstein and Arthur Zajonc write:

Most people tend to think of photons as being the constituents of light, in the same sense that atoms are the constituents of matter. But this view is erroneous. While a brick contains a definite number of atoms, the same cannot always be said for light. Most forms of light—sunlight, for example, or light from electric bulbs—are not composed of one photon, or ten photons, or any particular number of photons at all. . . . The central lesson . . . is that the concept of the photon is far more subtle than had been previously thought.²²

Elsewhere Zajonc writes: “Try though we may to split light into fundamental atomic pieces, it remains whole to the end. . . . Perhaps for light . . . the most fundamental feature is not to be found in smallness, but rather in wholeness, its incorrigible capacity to be one and many, particle and wave, a single thing with the universe inside.”²³ Zajonc offers this comment upon summarizing experimental results that fail to disclose light’s fundamental nature—wave *or* particle. Light’s capacity to straddle this dichotomy—waves and particles are mutually exclusive, from a classical standpoint—gives us a world that seems to have no conceptual bottom.

As for causality, light enjoys an intimate but not all-defining relationship with material objects. While, as already indicated, a flashlight or match can produce (cause) light, that light is caught only on the rebound, so to speak, of the material bodies it announces: it does not show up *by itself* as a caused event or effect. One does not see light *per se* in the intermediate emptiness, say, between flashlight and wall.

This indifference of light *per se* to self-announcement comports with light's intrinsic emptiness, for causal action requires temporal sequence (first cause, then effect), and relativity theory insists that light, from its own perspective, undergoes no temporal passage. This is another aspect of light that is surprising, but it is a well-established understanding of modern physics. Hermann Bondi states that light "cannot change once it has been produced, owing to the fact that it does not age, and therefore it must remain the same."²⁴ J. T. Fraser similarly writes, "All moments in the life of the photon are simultaneous."²⁵ Finally, Brian Greene explains that light, having zero rest mass, devotes all its motion to the three spatial dimensions and none to the time dimension. "Thus light does not get old; a photon that emerged from the big bang is the same age today as it was then. There is no passage of time at light speed."²⁶

I hasten to add that Bondi, Fraser, and Greene are referring to light moving in a vacuum, or light unaffected by material bodies. When this circumstance does not prevail, light is at the mercy of physical matter and may thereby be slowed, reflected, scattered, and so on. But again, this is light in conjunction with other things, or light coming to light (detection) by virtue of its association with those things. Without that association, light remains undetected and, if Einstein is correct, indifferent to the passage of time with its concomitant cause-and-effect linkages.

In brief, light is empty of parts, causes, and an apprehensible nature. And yet this emptiness produces a cosmos. Note how Sidney Perkowitz builds his description of the universe around light: "To the best understanding we can muster . . . the universe is made so that light always travels its own distance of zero, while to us its clock is stopped and its speed is absolutely fixed. These sober conclusions read as if they come out of some fevered fantasy. Light, indeed, is different from anything else we know."²⁷

Hans Reichenbach drives home the same point:

Clocks and yardsticks, the material instruments for measuring space and time, have only a subordinate function. They adjust themselves to the geometry of light and obey all the laws which light furnishes for the comparison of magnitudes. One is reminded of a magnetic needle adjusting itself to the field of magnetic forces, but not choosing its direction independently. Clocks and yardsticks, too, have no independent magnitude; rather, they adjust themselves to the metric field of space, the structure of which manifests itself most clearly in the rays of light.²⁸

My intent is not to try to explain why light, as defined by Einstein, is thought to possess universal relevance. Rather, I wish to point out that Einsteinian light affirms the Mahayanist belief that emptiness is world-generating. We may not be able

to find light *per se*, but it finds us in the circumambient guise of the cosmos. No-show emptiness gives birth to *maya*, the show of reality that consists of empty, unfindable objects.

I do not know how the show of reality issues up from the no-show emptiness that is light, but clearly something like this occurs in scientific experiment. We now know, from analysis of experimental results, that prior to observation (measurement) particles (atoms, electrons, photons, etc.) intrinsically lack properties that would make them real in the way we conventionally imagine them—as having definite momentum, spin, and polarization properties.²⁹ They do not have such (definite) properties, nor are they precisely located in space and time—until, that is, they are observed, at which time they appear as self-contained, self-existing entities. But this appearance arises from a deep ontological indeterminacy that borders on *śūnyatā*-like emptiness.

Up until recent decades physicists assumed that unobserved particles were no different from observed particles. Each possessed definite or determinate properties that rendered them distinct from other particles, and from the rest of the world. But quantum entanglement embodies the realization that two particles originating from a common event timelessly interact as they fly away from each other. From a classical (pre-quantum) perspective this is puzzling, and some say revolutionary. Robert Nadeau and Menas Kafatos propose that quantum entanglement “has more potential to change our conceptions of the ‘way things are’ than any previous discovery in the history of science.”³⁰

In the literature one encounters two or three ways of talking about quantum-entangled, timelessly interacting particles. Often the term “telepathic connection” (or something similar) is invoked to describe the effect, but insofar as this expression conjures up an image of two distinct, distantly separated particles timelessly interacting, it is misleading.³¹ The mathematics of quantum mechanics notates the particles as a unitary system, the two particles being *interdependently* suspended or superposed over a range of possible measurement values. When measurement occurs, consequently, the observation of either particle mathematically entails the observation of the other. But not, I submit, because the two particles are distinct, self-contained entities somehow telepathically connected across space.

A better way of talking recognizes that the particles are *śūnya* or open to the point of remaining dependent on each other for their delicate, co-evolving ontology. Since neither possesses the properties required to establish itself as a hard-edged, self-centered entity, each is wide open to the world. To some degree, this realization is implicit in the oft-noted observation that particles are waves prior to measurement. Waves, as classically understood and as explained earlier, are nothing in and of themselves. Instead they borrow their reality from other things; they are the wave action of those things, and wave action suggests widely extended, relational inclusivity rather than particulate, point-like exclusivity or self-containment. Wave action also connotes ongoing action or becoming, in contrast to the notion of particle stability, even changelessness, which has, until recent decades, prevailed in the West.³² One way of grasping quantum entanglement subsists in the realization that, prior to

measurement, wave-like particles are unbounded portions of each other, not just by reason of their wide extension but, more fundamentally, by reason of their indeterminate mutuality.

And also, I would like to suggest, by reason of the primal emptiness of a universe still in its inception. Both quantum entanglement and *śūnyatā* mark that aspect of reality that is still innocent of what it might yet be—still indeterminate, still quivering with possibility, and still lacking the ontological wherewithal to afford us secure intellectual footing in the cosmos. The ancient Egyptians imagined a mound of creation emerging from the primeval waters, a stable hillock from which humankind could draw ongoing permanency. Physicists once imagined and looked for a similar mound but instead have found ever deeper iterations of empty openness. In reflecting on what modern physics has revealed regarding the nature of reality, Kenneth Ford writes: “Knock on wood. It seems solid. It *is* solid. But probe more deeply and you encounter other worlds.”³³ Each world, I might add, being more capacious and emptier than the one before, and each therefore more charged with creative potential. This is reality before the appearance of hard-edged, self-isolated entities, and physics revisits it every time distant particles are found to be entangled.

Image-empty Light and Śūnyatā

The foregoing probably raises more questions than it answers, but that is consistent with Ralph Baierlein’s remark that “light, it seems, is always ready with another surprise.”³⁴ Moving to the relatively simple idea of a particle of light or photon (simple, at least, at first blush), I wish now to propose that image-empty light particles reenact quantum entanglement with its surprising demonstration of instantaneous or point-like togetherness. One can, that is, get an intuitive feel for what entanglement involves, and for what *śūnyatā* entails, by contemplating what light can and cannot be.

As I insisted earlier, light cannot be self-announcing; its nature is to announce other things, and only then do we become aware of light. Let us then empty light of this one property—visibility or visual self-announcement—and see what happens. My argument goes as follows.

1. By means of light, material objects cast off reflections or images of themselves.
2. This allows them to interact at a distance, as people do when waving to each other.
3. Light, however, is constitutionally unable to cast off an image of itself, for the clear seeing of other things requires that it remain unseen.
4. Lacking the ability to cast off an image of itself, light also lacks the ability to interact at a distance by means of images.
5. If, therefore, interaction occurs between separate parts of light—individual photons, say—it does so on a basis different from that of material bodies.
6. This basis is hinted at in experiments that indicate that photons timelessly interact across arbitrarily large space intervals.

7. I have proposed that such timeless interaction occurs by virtue of the indefinite nature of the photons: empty of determinate properties that would otherwise allow them to snap into place as distinct, self-contained entities, they are open to, and ontologically inseparable from, other similarly empty photons.
8. If image-empty photons interact, it seems they would be no more successful in maintaining their separate individuality across space than quantum entangled particles. Unable to cast off images of themselves, they would have to interact at the same place, which suggests that within each part of light—each photon—all other interacting parts are wholly present or fully arrived.

Recall Zajonc's supposition:

Perhaps for light . . . the most fundamental feature is not to be found in smallness, but rather in wholeness, its incorrigible capacity to be one and many, particle and wave, a single thing with the universe inside.³⁵

While this supposition is conjectural, it points up the philosophical turbulence that now informs physics. Some of this turbulence tracks back to misgivings about the clockwork universe, the view that reality ultimately reduces to separately existing objects, all in mechanical interaction. To follow Lee Smolin:

Does the world consist of a large number of independently autonomous atoms, the properties of each owing nothing to the others? Or, instead, is the world a vast, interconnected system of relations, in which even the properties of a single elementary particle or the identity of a point in space requires and reflects the whole rest of the universe?³⁶

Smolin's response is that the so-called parts of reality are mutually immanent: each "requires and reflects the whole rest of the universe." The world is therefore a "network of relations," and features of reality (like space, time, and atoms) that we often regard as inherently real "have meaning only to the extent that they stand for the complexity of the relationships between the things that happen in the world."³⁷

Relationality, I submit, implies interactive emptiness, a kind of ontological self-slippage away from selfness or ipseity. Since nothing can exist on its own, whatever does exist draws or borrows its existence from other things by means of relation. It also reciprocates, slipping into and lending existence to other things, all in a delicate haze of back-and-forth relationality. Objects borrow their fragile existence from a wide interplay of indeterminate, unsettled emptiness. As Nāgārjuna wrote: "Whatever is dependently co-arisen / That is explained to be emptiness."³⁸

This analysis leaves some questions unanswered. Readers might wish to know, for example, why material particles like electrons align with immaterial (zero rest mass) photons in manifesting entanglement tendencies. Isn't light distinct from material reality? Not really, I would say. Along with instantiating the unfindability of parts, causes, and an apprehensible nature, light expresses the unfindability or emptiness of distinctions that would cordon it off from other things. Thus it possesses universal relevance. While it is, as Perkowitz says, "different from anything else we know,"³⁹ it

may nevertheless be all we know. “Seeing light,” writes Zajonc, “is a metaphor for seeing the invisible in the visible, for detecting the fragile imaginal garment that holds our planet and all existence together. Once we have learned to see light, surely everything else will follow.”⁴⁰

To contemplate the “fragile imaginal garment” of light is to contemplate *śūnyatā*.

Notes

- 1 – Abner Shimony, *Search for a Naturalistic World View*, vol. 1, *Scientific Method and Epistemology* (Cambridge, UK: Cambridge University Press, 1993), p. 63.
- 2 – Elizabeth Napper, *Dependent-Arising and Emptiness: A Tibetan Buddhist Interpretation of Mādhyamika Philosophy Emphasizing the Compatibility of Emptiness and Conventional Phenomena* (Boston: Wisdom Publications, 2003), pp. 3–4.
- 3 – C. W. Huntington, Jr., with Geshé Namgyal Wangchen, *The Emptiness of Emptiness: An Introduction to Early Indian Mādhyamika* (Honolulu: University of Hawai’i Press, 1989), p. 32.
- 4 – And, more than that, even these characteristics, according to Nāgārjuna, cannot ultimately be found. They offer nothing to “settle down in,” “nothing to hold on to,” as Nancy McCagney has put it, because they also fail to exist on their own merit (McCagney, *Nāgārjuna and the Philosophy of Openness* [Lanham, MD: Rowman and Littlefield, 1997], pp. 31–32).
- 5 – The image is from Chiyono’s “enlightenment poem”:

With this and that I contrived
And then the bottom fell out of the bucket.
Where water does not collect,
The moon does not dwell.

—Translation by Anne Dutton, in *Zen Sourcebook: Traditional Documents from China, Korea, and Japan*, ed. Stephen Addiss (Indianapolis: Hackett Publishing, 2008), p. 179.
- 6 – Francesca Fremantle, *Luminous Emptiness: Understanding the Tibetan Book of the Dead* (Boston: Shambhala, 2001), p. 79.
- 7 – Albert Einstein, “Zur Elektrodynamik bewegter Körper,” *Annalen der Physik* 17 (1905): 892.
- 8 – Arthur Zajonc, *Catching the Light: The Entwined History of Light and Mind* (New York: Oxford University Press, 1993), p. 260.
- 9 – To follow N. David Mermin: “How can this be? How can there be a speed c with the property that if something moves with speed c then it must have the speed c in any inertial frame of reference? This fact—known as the *constancy of*

the speed of light—is highly counterintuitive. Indeed, ‘counterintuitive’ is too weak a word. It seems downright impossible” (Mermin, *It’s About Time: Understanding Einstein’s Relativity* [Princeton: Princeton University Press, 2005], p. 25; original emphasis). Mermin goes on to explain that light speed constancy implies the plasticity of space and time: the spacetime values of material bodies are keyed to the speed of light so as to ensure that no material body ever reaches that speed.

- 10 – *The Fundamental Wisdom of the Middle Way: Nāgārjuna’s Mūlamadhyamakārikā*, trans. Jay L. Garfield (New York: Oxford University Press, 1995), XIII:8 (p. 36).
- 11 – David Loy, *Nonduality: A Study in Comparative Philosophy* (Amherst, NY: Humanity Books, 1988), p. 20.
- 12 – Jonathan Powers writes: “When we see an object we see patches of colour, of light and shade. We do not see a luminescent stream flooding into our eyes. The ‘light’ we postulate to account for the way we see ‘external objects’ is not given in experience; it is inferred from it” (Powers, *Philosophy and the New Physics* [London: Methuen, 1982], p. 4). P. W. Bridgman’s comment is also apropos: “The most elementary examination of what light means in terms of direct experience shows that we never experience light itself, but our experience deals only with things lighted. This fundamental fact is never modified by the most complicated or refined physical experiments that have ever been devised” (Bridgman, *The Logic of Modern Physics* [New York: Macmillan, 1955], p. 151). Finally, James J. Gibson writes:

A single point of light in an otherwise dark field is not “light”; it specifies either a very distant source of light or a very small source, a luminous object. A single instant or “flash” of such a point specifies a brief event at the source, that is, the *on* and the *off*. A fire with coals or flames, a lamp with a wick or filament, a sun or a moon—all these are quite specific objects and are so specified; no one sees mere light. What about a luminous *field*, such as the sky? To me it seems that I see the sky, not the luminosity as such. What about a *beam* of light in the air? But this is not seeing light, because the beam is only visible if there are illuminated particles in the medium. The same is true of the shafts of sunlight seen in clouds under certain conditions. (Gibson, *The Ecological Approach to Visual Perception* [Hillsdale, NJ: Lawrence Erlbaum Publishers, Inc., 1986], p. 54; original emphasis)

Other statements to the same effect from a broad range of thinkers could be offered, but I hope these suffice to make the general point.

- 13 – With this thought in mind, Hans Blumenberg describes light as “the ‘letting appear’ that does not itself appear . . . the gift that makes no demands, the illumination capable of conquering without force” (Blumenberg, “Light as a Metaphor for Truth: At the Preliminary Stage of Philosophical Concept Formation,” in David Michael Levin, ed., *Modernity and the Hegemony of Vision* [Berkeley: University of California Press, 1993], p. 31).

- 14 – Here I am speaking of the classical vacuum, or the vacuum imagined up until the realization of the quantum vacuum. The introduction of light would add to the energetic nature of the quantum vacuum, but that would not rule out or contradict my present point. The quantum vacuum, I believe, also instantiates *śūnyatā*, but that is a subject for another article. See John D. Barrow, *The Book of Nothing: Vacuums, Voids, and the Latest Ideas about the Origins of the Universe* (New York: Pantheon Books, 200), pp. 35–48.
- 15 – Fremantle, *Luminous Emptiness*, p. 39.
- 16 – Ibid.
- 17 – Scott Clark, *Japan, A View from the Bath* (Honolulu: University of Hawai'i Press, 1994), p. 7.
- 18 – Pema Chödrön, "Taking the Leap," in *The Best Buddhist Writing 2010*, ed. Melvin McLeod and the Editors of the *Shambhala Sun* (Boston: Shambhala, 2010), pp. 155–156.
- 19 – David Loy insists that Buddhism propounds "an interdependence so great that I am you." See his *Lack and Transcendence: The Problem of Death and Life in Psychotherapy, Existentialism, and Buddhism* (Amherst, NY: Humanity Books, 1996), p. xv; original emphasis. Cf. Arthur Schopenhauer's belief that compassion dissolves "the distinction between self and not-self," in *Human Nature*, trans. T. Bailey Saunders, eBooks@Adelaide. At <http://ebooks.adelaide.edu.au/s/schopenhauer/arthur/human/chapter1.html> (visited 23 March 2012).
- 20 – I take this felicitous expression from L. Pearce Williams, *The Origins of Field Theory* (New York: Random House, 1966), p. 116. Along with light and the quantum vacuum (see p. 447 n. 14 of this article), field theory invites comparison with *śūnyatā*.
- 21 – Zajonc, *Catching the Light*, p. 299.
- 22 – George Greenstein and Arthur Zajonc, *The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics* (Boston: Jones and Bartlett, 1997), p. 35.
- 23 – Zajonc, *Catching the Light*, p. 299.
- 24 – Hermann Bondi, *Relativity and Common Sense: A New Approach to Einstein* (Garden City, NY: Anchor Books, 1964), p. 108.
- 25 – J. T. Fraser, *The Genesis and Evolution of Time: A Critique of Interpretation in Physics* (Amherst, MA: University of Massachusetts Press, 1982), p. 39. See also J. T. Fraser, *Time: The Familiar Stranger* (Amherst, MA: University of Massachusetts Press, 1987), pp. 222–242.
- 26 – Brian Greene, *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory* (New York: Vintage Books, 2000), p. 51.

- 27 – Sidney Perkowitz, *Empire of Light: A History of Discovery in Science and Art* (New York: Henry Holt and Company, 1996), p. 76.
- 28 – Hans Reichenbach, *From Copernicus to Einstein*, trans. Ralph B. Winn (New York: Philosophical Library, Inc., 1942), pp. 67–68. Arthur Stanley Eddington writes: “The speed of 299,796 kilometres a second which occupies a unique position in every measure-system is commonly referred to as the speed of light. But it is much more than that; it is the speed at which the mass of matter becomes infinite; lengths contract to zero, [and] clocks stand still. Therefore it crops up in all kinds of problems whether light is concerned or not” (Eddington, *The Nature of the Physical World* [London: J. M Dent and Sons, 1964], p. 64).
- 29 – A good explanation for quantum entanglement may be found in N. David Mermin’s “Quantum Mysteries for Anyone,” *Journal of Philosophy* 78, no. 7 (July 1981): 397–408.
- 30 – Robert Nadeau and Menas Kafatos, *The Non-Local Universe: The New Physics and Matters of the Mind* (Oxford: Oxford University Press, 1999), p. vii.
- 31 – See, for example, Dean Radin, *Entangled Minds: Extrasensory Experiences in a Quantum Reality* (New York: Pocket Books, 2009).
- 32 – As the following statement by a prominent nineteenth-century physicist (Lyon Playfair) indicates, the atom was once regarded as absolute bedrock, and so unscathed by flux as to warrant comparison with fixed scientific truth: “An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle of existence” (George Basalla, William Coleman, and Robert H. Kargon, eds., *Victorian Science: A Self-Portrait from the Presidential Addresses of the British Association for the Advancement of Science* [Garden City, NY: Anchor Books, 1970], p. 82).
- 33 – Kenneth W. Ford, *The Quantum World: Quantum Physics for Everyone* (Cambridge, MA: Harvard University Press, 2005), p. 1. What Ford has in mind are worlds akin to the scientifically pronounced emptiness of ordinary objects. In a lecture given in Edinburg in 1927, Arthur Stanley Eddington noted that, thanks to science, the kitchen table he had known since childhood is now two tables. On the one hand, it is a solid, weighty, enduring, colored object—the very antithesis of blank, empty space. And yet, on the other hand, it is “mostly emptiness,” the “combined bulk” of its constituents adding up “to less than a billionth of the bulk of the table itself” (Eddington, *The Nature of the Physical World*, p. 6). Since Eddington’s address, the demolition job that science had performed on the everyday table has been repeated at deeper levels.
- 34 – Ralph Baierlein, *Newton to Einstein: The Trail of Light* (Cambridge: Cambridge University Press, 2001), p. 95.
- 35 – Arthur Zajonc, *Catching the Light*, p. 299.

- 36 – Lee Smolin, *The Life of the Cosmos* (New York: Oxford University Press, 1997), p. 221.
- 37 – *Ibid.*, pp. 276, 214. An entity's relation to the world, it seems, is part of the entity itself. As Ilya Prigogine and Isabelle Stegners put it, physics "now recognizes that, for an interaction to be real, the 'nature' of the related things must derive from these relations, while at the same time the 'relations' must derive from the nature of the things" (Prigogine and Stegners, *Order out of Chaos: Man's New Dialogue with Nature* [Toronto: Bantam Books, 1985], p. 95).
- 38 – Garfield, *The Fundamental Wisdom of the Middle Way*, XXIV:18 (p. 69).
- 39 – Perkowitz, *Empire of Light*, p. 76.
- 40 – Zajonc, *Catching the Light*, p. 343.