RAPHAEL AFILALO AND HYMAN SCHIPPER

The Kabbalistic Radla and Quantum Physics: Analogies and Differences

There currently exists a burgeoning literature that attempts to relate contemporary science—and in particular, quantum physics—to the Jewish mystical tradition.[1] This enterprise is pursued for varied purposes. Sometimes religious Jews mobilize the similarities in an attempt to show what they regard as the prescience of Kabbalah, its foreknowledge of modern physics; sometimes scientists, whether religious or not, extract from Kabbalah metaphors that clarify or lend vividness to scientific theories, particularly in cosmology; and sometimes the enterprise is pursued simply because it is interesting and curious that ostensibly disparate systems—one founded on empirical research, the other virtually anti-empirical—can have such affinities with each other. We live in an age in which, for whatever reason, Kabbalah and mysticism in general resonate intellectually, emotionally, and spiritually, and in which mysticism and science show an unprecedented degree of confluence.

1. See Nathan Aviezer, "Kabbalah, Science, and Creation," *Jewish Action* 65 (Fall2004/5765); Daniel Matt, *God and the Big Bang: Discovering Harmony between Spirituality and Kabbalah* (Woodstock, Vt, 1996); Adam McLean, "Kabbalistic Cosmology and its Parallels to the Big Bang of Modern Physics," *Hermetic Journal* 39 (1988):11; Joel R. Primack and Nancy Ellen Abrams, "In A Beginning: Quantum Cosmology and Kabbalah," *Tikkun* 10 (1995): 66-73; Aaron M. Schreiber, *Quantum Physics, Jewish Law, and Kabbalah: Astonishing Parallels* (New York, 2009); Gerald Schroeder, *Genesis and the Big Bang: The Discovery Of Harmony Between Modern Science And The Bible* (New York, 1991); Howard Smith, *Let There Be Light: Modern Cosmology and Kabbalah: A New Conversation Between Science and Religion* (Novato, CA, 2006). (Not all these books and articles highlight quantum mechanics, but all engage contemporary physics.)

RAPHAEL AFILALO is Chief of Pastoral Services at the Jewish General Hospital and spiritual leader of the Ramḥal Synagogue in Montreal. He is an authority on the writings of R. Mosheh Ḥayyim Luzzatto and the author of five books on the Kabbalah.

HYMAN SCHIPPER is a professor of neurology and medicine at McGill University and a clinician-scientist at the Jewish General Hospital (Montreal). He has an interest in issues at the intersection of Torah, philosophy, and contemporary science.

We agree that fundamental concepts of twentieth century physics have analogues in Kabbalah, and our innovation in this paper is to introduce into an ever-growing discussion a particular Kabbalistic construct known as *Radla*, found in Lurianic Kabbalah and developed by R. Mosheh Ḥayyim Luzzato (Ramḥal). There are striking parallels between statements about *Radla* made by Kabbalists and statements by twentieth century physicists, in particular about Heisenberg's uncertainty principle (UP). Of course, there are differences too. Note that most attempts to relate quantum physics to Kabbalah have focused on cosmology—views about the origins of the universe.[2] We focus on descriptions of a world already in place.

Importantly, we do not argue that Kabbalists of centuries ago were prescient and knew quantum physics. After all, non-Jewish metaphysical systems contain motifs that are similar to the kabbalistic ones we explore, and we would not attribute prophetic gifts to them.[3] Nor will we explore in depth the fascinating question of how to account for the similarities between mystical systems as a collective– systems not founded on experimentation and which indeed make claims that are counterintuitive and contrary to ordinary experience—and scientific theories that put forth similar-sounding counterintuitive claims. Rather, our aim is to present certain similarities between the metaphysics of *Radla* and quantum physics to demonstrate how they resonate with and complement one another, and to note differences. We also wish to comment on the value of such exercises.

We will first present briefly the ontology of quantum mechanics (QM), with emphasis on Heisenberg's principle. We then explain the *Radla* concept, and next illustrate similarities between that system and contemporary physics. We then note certain limitations of the analogies. In the concluding section, we reflect on the value of comparisons between Kabbalah and science, and discuss some implications of their similarities for science, religion, and our understanding of the universe.

I. Quantum Mechanics

A. Historical Perspective

Quantum mechanics (QM) is a highly successful discipline of physics that builds upon and transcends classical (Newtonian) conceptualizations of

2. This should be evident from the titles of the works cited in note 1.

3. For example, Plotinus's *Enneads* 5. Of course, the fact that a particular argument for Kabbalistic prescience is suspect because non-Jewish systems likewise resemble claims of modern science, does not refute the position that Kabbalah is a product of divine revelation. Rather, it undercuts a particular argument for that claim. But again, we bracket these questions.

physical reality.[4] It is very much a product of the twentieth century, with many identifying its origins with the discovery of "blackbody radiation" (the delivery of energy in discrete packets, or "quanta") by Max Planck in 1900. A quantum mechanical understanding of space, time, matter, and energy unfolded apace with the seminal contributions of Albert Einstein, Ernest Rutherford, Niels Bohr, Erwin Schrodinger and others in the first half of the latter century. During the last sixty years, input from outstanding physicists, such as Richard Feynman, Stephen Hawking, and Edward Witten, have enabled further refinements of the theory, contemporaneous with the advent of numerous technological innovations based on this knowledge.

The astounding success of QM has led to the widespread belief that the most fundamental principles underpinning physical existence are now known and that all that remains to be accomplished is more refined and precise measurement of the phenomena disclosed. However, the latter is by no means a simple task. As discussed below, the very act of measurement, when conducted on the infinitesimally small quantum scale, necessarily perturbs and is inextricably linked with the system undergoing observation.

B. The Heisenberg Uncertainty Principle

In 1927, Werner Heisenberg published his seminal paper on the "uncertainty principle" in *Zeitschrift fur Physik*. The UP maintains that paired physical properties of a system cannot both be measured to arbitrary precision; the more accurately one property is known, the less precisely the other can be known. Importantly, this is not contingent upon the resolution of the measuring apparatus or the skills of the observer, but is an inherent characteristic of physical systems as dictated by the equations of quantum mechanics. While it is true that the very act of measurement affects the physical properties of particles (e.g., its position or momentum), the UP makes a more fundamental claim—that we *cannot* know, as a matter of principle, the present in all its details.[5]

In classical physics, it is theoretically possible to determine the position and momentum of every particle in the universe and thereby predict the future with complete precision. In contemporary quantum physics, it is fundamentally impossible to predict future events because one can never attain full knowledge of the position and momentum of even a

4. See David Z. Albert, *Quantum Mechanics and Experience* (Cambridge, MA, 1992); John Gribbin, *In Search of Schrödinger's Cat* (New York, 1984); Steven Weinberg, *Dreams of a Final Theory* (New York, 1992). Our criteria for "success" are common ones—explanation, prediction, control, and technological application.

5. Werner Heisenberg, "Über den anschulichen Inhalt der quantentheoretischen Kinematik und Mechanik," *Zeitschrift für Physik* 43 (1927): 172–98.

single particle. In the standard (Copenhagen) interpretation of quantum mechanics (e.g., the results of the famous "2-slit experiment"[6]), every possible outcome for an event, represented mathematically as a statistical wavefunction, exists in the unobserved state. The act of observation engenders a "collapse of the wavefunction," whereby one of these many potential outcomes is "selected" as the reality actually experienced.

The Copenhagen interpretation of QM was strengthened after attempts to refute it failed. Examples of such investigations include the "gedanken (thought)" experiments of the famous Einstein-Bohr debate of the 1920's[7] and, more tellingly, resolution of the EPR (Einstein-Podolsky-Rosen) paradox,[8] which resulted from repeated experimental violation (1972-1982) of "Bell's inequality" (1964) in favor of quantum theory.

Moreover, the results of these experiments (especially that of Alain Aspect in 1982) implied that all particles emerging from the Big Bang maintain an indefinite "connectedness" to one another and that each particle therefore "knows" about the existence of every other particle. Furthermore, the Copenhagen interpretation embodies the concept of preserved complementarity, whereby the properties of one particle (e.g., position, momentum, spin, etc.) change instantaneously and commensurate with changes in a "partner" particle, regardless of the extent of their physical separation (Einstein's "spooky action at a distance"). For the latter to occur by classical causal interaction, information would need to pass from particle A to particle B at impossible supraluminal speeds. Quantum theory dictates that the shared history of the two particles forever "locks" them in a reciprocal dance ("quantum entanglement") that does not require new information to pass between them ("acausality").

In this article, we will refer primarily to the classical Copenhagen interpretation of QM. However, the reader should be aware that there exist competing variations of this interpretation (e.g., Bohr vs. Von Neumann), as well as several non-Copenhagen conceptualizations. Prominent among the latter are Heisenberg's Ghost Reality, Einstein's Neo-Realism, David Finkelstein's New Quantum Logic, David Bohm's Undivided Wholeness (cited in section III.6), Hugh Everett's Many-Worlds interpretation, and Information Theory.[9] As one illustration of a distinctly non-Copenhagen

6. Explained in, *inter alia*, Gribbin, 154-57.
7. See Abraham Pais, *Subtle is the Lord* (Oxford, 1982).
8. Albert Einstein, Boris Podolsky, and Nathan Rosen, "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?" *Physical Review* 47:10 (1935): 777–80.
9. See Charles Seife, *Decoding the Universe* (London, 2006).

perspective, Everett's model of QM states that all outcomes that could possibly occur actually do so in some version of reality. In this model, observations do not "collapse" the wavefunction into a singular reality but generate a multiverse of innumerable parallel, non-intersecting worlds.[10]

II. The Kabbalah

The Kabbalah teaches about the beginning of Creation, the unfolding of worlds, and the various lights or energies that emanate from the highest level of the superior worlds to our existence. It explains, often allegorically, the mysterious ways in which God guides the universe and the dynamic systems that are put in place to interact with Nature and Man. As depicted in the Kabbalah, the universe is guided by a complex system of "forces" or "lights," which, through their interactions, provoke chain reactions that impact Man and the world.[11] The concept of quantum mechanics approximates the Kabbalistic view of the universe's fundamental unity and the idea that all semblances of separateness and differentiation become apparent only after "filtration" of the one Infinite Light (*Or Ein Sof)* through the various *Sefirot*.

The primary Kabbalistic texts we will use are the *Zohar*, the teachings of R. Yiẓḥak Luria (*Arizal*; 1534-1572) as transmitted by his student R. Ḥayyim Vital (1543-1620), and the works of R. Mosheh Ḥayyim Luzzatto (*Ramḥal*; 1707-1746]). The *Arizal* elaborated all the main concepts of the Kabbalah and provided innovative explanations of the *Sefirot* and *Parẓufim* (configurations). The corpus *Eẓ Ḥayyim*, compiled by R. Ḥayyim Vital, encompasses the teachings of the *Ari* and remains the major reference text of Lurianic Kabbalah. In eighteenth century Europe, *Ramḥal* greatly facilitated the contemporary understanding of the Kabbalah by explicating and organizing many cryptic passages of the *Zohar* and *Eẓ Ḥayyim*.[12]

A. The Sefirot and Parẓufim

Although the Light (emanation) of the Infinite is a unified whole, each of ten *Sefirot* represents a "filter" that holds and transforms a certain part of this light into a particular force, attribute, or action. Each *Sefirah* is composed of a vessel (*keli)* which holds its part of light (*or)*. There is no differentiation of the *or* within the *keli* itself, since it is a part of the original light; differences emerge from the particularity or position of the

10. Hugh Everett, "Relative State Formulation of Quantum Mechanics," *Review of Modern Physics* 29 (1957): 454-62.
11. See Raphael Afilalo, *Kabbalah Concepts* (Montreal, 2006), 13.
12. See ibid.

Sefirah. Arrangements of ten *Sefirot* are the blueprint of all things created, as everything that exists is comprised of ten forces.

A *Parẓuf* (face, visage, or countenance) is a configuration of one or more *Sefirot* acting in coordination. Some *Parẓufim* are masculine, while others are feminine. The masculine correspond to kindness—*Ḥesed*—and are manifestations of the Divine name of *MaH* (45 in *gematriyah*, derived from the numerical rendering of a specific configuration of the Tetragrammaton). The feminine correspond to *Gevurah*—a word that in Kabbalah refers not to rigor alone, but to a combination of rigor and limitation—and are manifestations of the name of *BaN* (numerical value of 52). Different formulae of the unions (combinations) of *MaH* and *BaN* (*Ḥesed* and *Gevurah*) are responsible for bringing into existence and guiding the Creation. The *Parẓufim* exist in a dynamic state of action, illumination, and interaction referred to as *tikkunim* of the *Parẓufim*. The *tikkunim* transduce the Higher Will into particular effects for the guidance of the universe; certain manifestations vary with time and are influenced by the actions of Man.

The six main *Parẓufim* (in order of spiritual "descent") are:

- *Attik Yomin*—Ancient of Days
- *Arikh Anpin*— Long Countenance
- *Abba*—Father
- *Imma*—Mother
- *Ze'ir Anpin*—Small Countenance
- *Nukva*—Feminine

B. The Radla

The configuration *Attik Yomin* is superior to all the configurations and is itself composed of ten *Sefirot*. Its manifestation of the name *MaH* (45) corresponds to its masculine principle; its manifestation of the name of *BaN* (52) corresponds to its feminine principle. It is the innermost configuration, the leading force and the source of all the others.

The guiding force for all existence "under" the *Parẓuf Attik Yomin* comprises the first three *Sefirot* of its *Nukva*/feminine aspect. Together they constitute the *Radla*— רישא דלא אתידע, the "Unknowable Head." The term is found in the Zohar.[13] The *Radla* encompasses all possible realities; everything that came or will come into existence has its roots in it. The *Radla* is called unknowable because the outcomes of its actions (in unfolding the Creation) are in no way graspable by our understanding or imagination.

13. *Zohar* 3:288b. Earlier roots are not significant for our purposes.

All possibilities exist within her, but in our perceived reality, they manifest themselves in all manner of uncertainty in which what appears to be is and is not at the same time. These counterintuitive notions of multiple and contrary realities are inherently paradoxical and unique to the *Radla.*

III. The Radla and Quantum Uncertainty

In this section, key descriptions of quantum uncertainty and the *Radla* are juxtaposed in order to underscore their similarity of meaning. The sources regarding the latter are mostly *Ramḥal*'s writings because of his tendency to explain these concepts in a more systematic fashion than earlier sources.

In drawing these comparisons, we are sensitive to a distinction between two categories of uncertainty: epistemological uncertainty (the inability of human beings to know the ultimate reality due to limitations of their cognitive faculties) and ontological uncertainty (the inherent unknowability of ultimate reality due to its character). The former, which represents the term's ordinary usage, focuses on cognitive limitations of human beings, the latter on the reality itself. The terms "inherent unknowability" and **"**character of reality**"** are very difficult to define, but one instance of ontological uncertainty would be a self-contradictory reality. Although many of our quotations from Kabbalistic literature reflect only the thesis of epistemological uncertainty, several of the passages we will cite verge on, if not enter into, ontological uncertainty of the sort found in contemporary physics.

1. The Fabric of Reality

Leading physicists have underscored the inadequacy of classical physics in fully explaining physical existence, the quantum worldview, and the essential significance of the "Uncertainty Principle." Kabbalistic sources similarly implicate the *Radla* construct as the ultimate source or progenitor of physical reality. We do not mean for the quotations to be mapped one-on-one; rather, the quotations set out basic features of each theory, and we believe that, taken as a whole, the writings of quantum physicists and those of Kabbalists who discuss *Radla* show similar approaches to understanding reality.

A. Quantum Physics:

> "The great extension of our experience in recent years has brought light to the insufficiency of our simple mechanical conceptions and,

as a consequence, has shaken the foundation on which the customary interpretation of observation was based."[14]

"[Uncertainty is] perhaps the central feature of quantum theory."[15]

"The quantum is the crack in the armor that covers the secret of existence."[16]

"I would conclude that extra dimensions really exist. They're part of nature."[17]

B. The Kabbalah:

רדל"א הוא סוד חיבורי מ"ה וב"ן למעלה מקור לכל הנהגה.

"In the *Radla* is the secret of the union of *MaH* and *BaN* at their highest level, to become the origin of the total governance."[18] (Both QM and the *Radla* conception relate to the notion of total governance of the universe.)

שהיא הראשונה, שבה נולדים הספיקות בתחלה.

"[The *Radla*] is the source; from it issues forth all uncertainty at the outset."[19]

2. The Intrinsically Incomprehensible Universe

The overarching opinion of leading quantum physicists is that essential spacetime and the fabric of the Universe are unknowable *by their very nature*, and not on account of the imprecision of our measuring devices. Similarly, the Kabbalah in places indicates that the workings of the *Radla* are fundamentally opaque to human reason, not because of any limitations in our understanding *per se*, but as a consequence of the *Radla*'s inherent unknowability. The extent to which conceptual elucidation of this aspect of unknowability remained consistent across the centuries, spanning the writings of the *Zohar*, the *Arizal*, and the *Ramḥal*, is noteworthy and attests to the authors' conviction and fidelity to the *Zohar*'s intended meaning.

14. Niels Bohr, *Atomic Theory and the Description of Nature* (Woodbridge, CT, 1934/1987), 2.
15. Gribbin, *In Search of Schrödinger's Cat*, 155.
16. John Wheeler, as cited in Denis Brian, *Genius Talk: Conversations With Nobel Scientists and Other Luminaries* (New York, 1995), 122.
17. Edward Witten, as cited in Jeremy Bernstein, *Quantum Profiles* (Princeton, 2003), 138.
18. R. Mosheh Hayyim Luzzatto, *Kalach Pitḥei Ḥokhmah* (Friedlander, [1785] 1992), 297-98.
19. Ibid., 269-71.

A. Quantum Physics:

"Science cannot solve the ultimate mystery of nature."[20] (Although this and the idea in the next quotation have been expressed often--even before QM came on the scene-- QM provides an explanation for why science cannot solve the mystery.)

"We *cannot* know, as a matter of principle, the present in all its details."[21]

"In more than forty years, physicists have not been able to provide a clear metaphysical model [of quantum reality]."[22]

"It is safe to say that nobody understands quantum mechanics."[23]

"The creation lies outside the scope of the known laws of physics."[24]

"The very concept of spacetime…isn't precisely defined."[25]

B. The Kabbalah:

עתיקא דכל עתיקין , סתימא דכל סתימין, אתתקן ולא אתתקן , אתתקן בגין לקיימא כלא, ולא אתתקן בגין דלא שכיח.

"Ancient of all the ancients, concealed of all the concealed, acting and not acting, it [*Radla*] acts to sustain all. Not acting [from our perspective] because it is not in any way graspable."[26]

ואקרי מוחא עלאה, מוחא סתימא , מוחא דשכיח ושקיט, ולית דידע ליה.

"It [the *Radla*] is called the superior, concealed wisdom; a wisdom that may not be graspable or manifest; no one can understand it."[27]

עתיקא קדישא סתימא דכל סתימין, רישא דכל רישא רישא דלאו רישא, ולא ידע, ולא אתידע.

20. Max Planck, cited in *The Constants of Nature,* ed. John D. Barrow (New York, 2003), 23.
21. Heisenberg, "Über den anschulichen," 172-98.
22. Erwin Schrodinger, cited in Fritjof Capra, *The Tao of Physics An Exploration of the Parallels Between Modern Physics and Eastern Mysticism*, (Berkeley CA, 1975), 132
23. Richard Feynman, *The Character of Physical Law* (Boston, 1965).
24. Stephen W. Hawking, *The Large Scale Structure of Space-Time* (Cambridge, 2003), 364.
25. Edward Witten, *The Elegant Universe* in *Nova Science Programming* (July 2003): *wgbh/nova/elegant/view-witten www.pbs.org/.html.*
26. *Zohar* 3:288a, *Idra zuta*. The translation of דלא שכיח follows *Ha-Sullam* and *Matok Mi-Dvash.*
27. Ibid.

"*Attika Kadisha*, most concealed of all that is concealed, Heads of all heads [the construct above *Arikh* in all Worlds], a head which is not a beginning [there exist still higher realities than the *Radla*], presently not understandable and will never be understood."[28]

נקרא רדל"א ע"ש הספיקות שיש בה.

"It is called *Radla* because of all the uncertainties that are in it."[29]

אינם מושגים ונודעים כלל, זהו ענין דלא אתידע.

"We cannot imagine or know anything [of the *Radla*]. This is the concept of 'unknowable'" [by its very nature, and not merely unknown—R. A. and H. S.].[30]

כל זה הוא ענין הספיקות.

"All of this [the interaction of *MaH* and *BaN* in *Radla*] is the matter of 'uncertainty.'"[31]

3. Translation of Indeterminacy into Experiential Reality

Quantum mechanics and the Kabbalah concur that the principles governing the existence of our universe at its most fundamental level operate according to "laws" that differ radically from those mediating the day-to-day reality we experience. This paradoxical "disconnect" between the micro- and macro-worlds is amply acknowledged as the interface between quantum uncertainty and Newtonian mechanics in physics, and in the relation of the *Radla* to *Arikh Anpin* and "lower" manifestations within the Kabbalah's hierarchical cosmology. Both disciplines go to great lengths in their attempts to delineate precisely what takes place at this critical interface, aptly described by R. Mosheh Schatz as the enigmatic "great bridge" between the quantum and familiar words.[32] Ultimately, contemporary physics and the Kabbalah conclude that a thorough comprehension of the

28. *Zohar*, 3:288a, *Idra zuta*.
29. R. Yiẓḥak Luria, *Eẓ Ḥayyim,* 1: 178.
30. From at least one passage, it appears that we are not allowed to explain Radla, which ostensibly implies that Radla is comprehensible:

כי רדל"א היא עליונה מאד ואין בנו רשות לבאר ענינה.

"The *Radla* is most supreme and we are not allowed to explicate it."
However, because this passage is inconsistent with the many that stress the incomprehensibility of Radla, we are inclined to interpret it differently, e.g., we are barred from explaining it because we cannot understand it. Or perhaps, as will be suggested later, rare individuals can grasp it.
31. Luzzatto, *Kalach Pitḥei Ḥokhmah*, 268.
32. Mosheh Schatz, *Sparks of the Hidden Light* (Jerusalem, 1996), 54-57.

mechanism responsible for transducing quantum/*Radla* indeterminacy into experiential reality may never be achievable by dint of the former's inherent unknowability.

A. Quantum Physics:

"Everything we call real is made of things that cannot be regarded as real."[33]

"All we know about [the world] are the results of experiments [observations];" i.e. we have no knowledge about the complete state of even a single particle in the quantum realm which gives rise to the reality we perceive.[34]

B. The Kabbalah:

כי הז"ת המתפשטין בא"א, כבר אמרתי שהם לפי הנהגת הזמן.

"The seven lower *Sefirot* [of *Attik Yomin*] are enclothed in the configuration *Arikh Anpin* and, as I indicated, are expressed within [the governance of] time."[35] (*Arikh Anpin*/*Attik Yomin* is the transition point between the unknowable thought of the Creator and the familiar concept of time. Likewise, quantum uncertainty is translated into familiar spacetime.)

רדל"א היא עומדת למעלה מא"א, והוא סוד חיבור הנהגה הנצחיות בהנהגת הזמן.

"The *Radla* is above *Arikh Anpin* and is the secret of the union of the eternal and temporal guidance."[36] (See our comment to the preceding quotation.)

ולפי מה שמתנהג בה—נולד הנהגה גדולה בפרצופים אך בין היא ובין תולדותיה אינם מושגים ונודעים כלל.

"And from what occurs in it [the *Radla*], emanates the main guidance conveyed by the *Parẓufim*. From the *Radla* to its outcomes [in our experiential reality], we can grasp and understand nothing."[37]

33. Niels Bohr, cited in Thomas George Wisdom-of-the-Wise, www.wisdom-of-the-wise.com/Niels-Bohr-on-Theory.htm (2009).
34. Gribbin, *In Search of Schrödinger's Cat*, 161.
35. Luzzatto, *Addir ba-Marom* (J Spinner, [1780] 1995), 187. We have translated according to our understanding of the concepts in the passage, rather than the literal meaning.
36. Ibid.
37. Luzatto, *Kalach Pitḥei Ḥokhmah*, 267.

מקום ההנהגה לפי ענין התחברות של מ"ה עם ב"ן הוא ברישא דלא אתידע. ולפי מה שמתנהג בה—נולד הנהגה גדולה בפרצופים.

"The origin of the governance according to the amalgamations of *MaH* and *BaN* is in the *Radla*. And according to this governance, the main governance of the *Parẓufim* arises."[38] (This and the next quotation state that events—combinations of *MaH* and *BaN*—within the unknowable *Radla* give rise to the familiar emanation of the lower *Parẓufim*. Likewise, we find: "All actions performed in this world come about according to these amalgamations [of *MaH* and *BaN*]. Nothing that is not rooted there [in the *Radla*] can occur."[39] Here we have a homology to the translation of quantum uncertainty [which most likely is a probability curve] into defined realities.)

על פי כל החיבורים האלה נמצאים כל המעשים שנעשו ושנעשים בעולם. כי לא יהיה מה שלא הושרש כאן.

"All actions performed in this world come about according to these amalgamations [of *MaH* and *BaN*]. Nothing that is not rooted there [in the *Radla*] can occur."[40]

4. Worlds in Potentia

From the Copenhagen (and other) interpretations of QM stems the spectacular and counterintuitive notion that all possible outcomes of an event, as determined by the statistical wavefunction, indeed exist as potential states capable of exerting detectable influences within the familiar world.[41] This remarkable concept is similarly encapsulated in Kabbalistic accounts of the *Radla*.

A. Quantum Physics:

"In QM, every possible outcome for an event exists in the unobserved state prior to collapse of the wavefunction."[42]

B. The Kabbalah:

כל מיני החיבורים שהיה אפשר להמצא בין מ"ה וב"ן—באמת נעשו.

"Every combination of *MaH* and *BaN* [reality] that could possibly be found was, in fact, made."[43]

38. Ibid.
39. Ibid., 272.
40. Ibid.
41. Cf. the 2-slit experiment, n.7 above.
42. Gribbin, *In Search of Schrödinger's Cat*, 82.
43. Luzzatto, *Kalach Pitḥei Ḥokhmah*, 268.

5. The Inherently Paradoxical Universe

The tenets of QM and the *Radla* embody a definition of "paradox" that diverges from other conventional usages of the term. In general, we attribute paradox to an incomplete understanding of an event or state. We assume that the paradox would spontaneously dissolve upon elucidation of all its relevant components, belying an intuition that nature is inherently rational (non-paradoxical). Both QM and the Kabbalah teach that this belief in the rational nature of physical existence is ultimately incorrect; at its deepest level, the observable universe obeys laws that are fundamentally paradoxical. Far from merely representing a manifestation of the incompleteness of our knowledge, paradox is the warp and woof of physical reality.

A. Quantum Physics:

> "It's not that we can't simultaneously specify the position and motion of an electron, but that it *does not have* a simultaneous specific position and motion."[44]

According to the Copenhagen interpretation of QM, the superposition of states comprises many possible, even mutually-exclusive outcomes, e.g., a cat in a box that is both dead and alive in the famous Schrodinger thought experiment; or a single (unobserved) photon that passes simultaneously through slit A and B in the 2-slit experiment. Each time the cat (or photon) is observed, the wavefunction collapses, with repeated observations yielding one result or its opposite in seemingly random order. Although counter-intuitive, the "real" (macro-) world as we perceive it is a manifestation of this quantum uncertainty.[45]

B. The Kabbalah:

> ויש חיבורים הפכיים, ואף על פי כן שניהם נמצאים, כי הפרצופים מורכבים כך ומשניהם נמצאים איכויות בפרצופים. ולפי שליטתם למעלה—כך נעשה מה שנעשה בפרצופים, אך אינו מושג ונראה כלל.

"There are combinations [outcomes of *MaH* and *BaN*] which are opposites; still, both are there, because *Parẓufim* [which transmit the outcomes of the *Radla*] are constructed in that way and from these two [opposites] derive the qualities of the *Parẓufim*. According to their dominance above,

44. George Wald, cited in Denis Brian, *Genius Talk* (New York, 1995), 143
45. Albert, *Quantum Mechanics and Experience*, (Cambridge, 1992), 80-111; Weinberg, *Dreams of a Final Theory* (New York, 1992), 65-89.

actions are carried out by the *Parẓufim*; however, this is in no way evident or comprehensible."[46]

מה שהרישא הזאת עצמה, כפי מה שמשיגים בה, גורמת הספיקות האלה כי פעם אחת נראה שיש בה כך, ופעם אחת יש בה כך. . . . ואם מסתכלים באותו הענין יותר—נראה שאינו כך, אלא בדרך אחר מתחלף ממנו.

"This Head [*Radla*], from what we understand of it, causes all the uncertainties. One moment it appears that [the outcome is] one thing, in another moment it looks like something else. . . . If we look into this matter more deeply, it appears not this way, but in a changed manner."[47]

שאין הספיקות ההם כמו ספיקות דעלמא, שאנו בספק אם יש דבר אחד, או אם אינו, אלא האמת הוא, כל מה שאנו מזכירים בספיקות—כל אותם הדברים ישנם באמת בה.

"These 'uncertainties' [of the *Radla*] are unlike the uncertainties of the [familiar] world. In the latter, we may be uncertain whether a thing exists or not; whereas, in truth, all things perceived as 'uncertain' are present in her [the *Radla*]."[48] (In our opinion, this description of the inherent paradox of reality is the most supportive Kabbalistic statement in favor of ontological, as opposed to epistemological, uncertainty.)

6. Unicity on a Grand Scale

In virtually all of its iterations over the many centuries, a "prime directive" of the Kabbalah remains disclosure of the absolute oneness of the Creator and His Creation in the face of apparent separateness and individualization, with the *Radla* representing the critical nexus between the whole and its parts. Mainstream interpretations of contemporary quantum physics point similarly to a blatant interconnectedness of all particles and forces comprising the observable universe.

A. Quantum Physics:

"Quantum physics reveals a basic oneness of the universe."[49]

"The world acts more like a single indivisible unit, in which even the 'intrinsic' nature of each part (wave or particle) depends . . . on its relationship to its surroundings"[50]

46. Luzzatto, *Kalaḥ Pitḥei Ḥokhmah*, 268.
47. Ibid., 270.
48. Ibid.
49. E. Schrodinger, cited in Capra, *The Tao of Physics*, 68.
50. F. D. Peat, *Infinite Potential: The Life and Times of David Bohm* (New York, 1997), 106.

Experiments refuting challenges to QM (especially that of Alain Aspect in 1982) imply that particles sharing common origins maintain an indefinite "connectedness" with one another notwithstanding their separation in time and space.[51]

"The inseparable quantum interconnectedness of the whole universe is the fundamental reality, and [the] relatively independent behaving parts are merely particular and contingent forms within this whole."[52]

B. The Kabbalah:

דהא כלא ביה מתדבקן והוא מתדבק בכלא, הוא כלא.
"Everything is connected to it [the *Radla*] and it is connected to all; it encompasses all."[53]

שכל ההנהגה היא אור אחד. והנה רדל"א הוא מין אור אחד.
"All reality is [fundamentally] governed by a single light [force]. The [forces comprised by the] *Radla* is [are] in actuality a part of this encompassing light."[54]

להיות כל ההנהגה בכל חלק.
"So that the entire guidance [of the Universe] is contained within each of its parts."[55]

IV. Implications

We have attempted to show that concepts analogous to those associated with quantum uncertainty are manifested in the Kabbalistic concept of *Radla*. In both Kabbalah and contemporary physics, the reality of the familiar macro-world is entirely contingent upon (and flows from) fundamental, but counter-intuitive, phenomena. Within these fundamental

A similar and widely-cited statement by Bohm to this effect is: "individuality is only possible if it unfolds from wholeness." We could not identify the original source of this quote.
51. Griffin, 228-31.
52. David Bohm, "On the Intuitive Understanding of Nonlocality as Implied by Quantum Theory," *Foundations of Physics* 5 (1975): 93-109
53. *Zohar* 3:288a, *Idra Zuta.*
54. Luzzatto, *Kalaḥ Pitḥei Ḥokhmah*, 270.
55. Ibid., 273.

domains, there is no causality as we intuit it, but rather a non-deterministic universe in which multiple, even mutually exclusive possibilities co-exist for every possible outcome or observation. In both systems, nothing is known concerning the mechanism whereby "events" in the quantum/*Radla* realm "translate" into phenomena of the experiential world. Seemingly random, uncaused fluctuations inherent to this realm limit what can be predicted about all future events. The *Zohar* writes that the *Radla* "is not attainable by wisdom or knowledge; a Head which is not understandable and will never be understood." These words are an equally apt depiction of the quantum world.

It is interesting that an adherent of Kabbalah, if so disposed, has the capacity to embed quantum uncertainty within the *Radla* framework, thereby creating not only a parallelism but also a synthesis between Kabbalah and QM. Fig. 1 (p. 152) illustrates how such a synthesis might proceed. In this schema, the evolution and boundaries of human insight into the fabric and workings of the universe are represented by a set of three stacked cubes: a small Classical (Newtonian) box contained within an intermediate Quantum box, which, in turn, is encompassed by a large Kabbalah box. The perimeters of the cubes denote the theoretical limits of fundamental knowledge about the universe attainable by each discipline. In the classical (pre-quantum) era, Newtonian physics sufficed to resolve, with relative precision, numerous queries concerning the mechanical operations of the universe (line 1). Deeper, more refined insights into the nature of reality could only be roughly approximated by (or were entirely opaque to) Newtonian thought and required the advent of quantum theory for their satisfactory resolution (line 2). The tenets of QM dictate that it is impossible to predict future events with any degree of certainty because one can never attain full knowledge of the position and momentum of even a single particle. But this statement may be true only within the Quantum box which, restricted by the UP, establishes a barrier beyond which science cannot probe. By contrast, in Kabbalah there are named constructs, such as the masculine aspect of Attik Yomin (mentioned above) and Adam Kadmon, *which are beyond or "outside" the Radla*. These Divine manifestations lie beyond the reach of science but are still potentially available to human insight (line 3). In this respect—the existence of a realm 'beyond' the Radla—Kabbalistic cosmology differs from the tenets of QM.

How can this realm beyond the *Radla* be accessed? One plausible answer is: prophecy (*nevu'ah*). Indeed, the existence of the realm beyond or

outside the *Radla* affords a suggestion for understanding the nature of prophecy in the *Radla* framework. On rare occasions, the Creator confers upon select persons the capacity for prophetic vision. From the current perspective, one might say that, in these instances, God wills individual minds to transcend spacetime and the indeterminacy of the *Radla* (point Y in Fig. 1) in order to glimpse the singular reality of the Divine plan. This would entail, of necessity, the suspension of the randomness of quantum uncertainty for as long as the *Radla* barrier is rendered permeable to the prophet's thought. Scripture suggests further (e. g., Num. 12:6-8) that this anomalous peek behind the *Radla* curtain and the ensuing awareness of Divine Intent varies in duration and lucidity commensurate with the stature of the individual prophet.

We may go a step further. Consider the Torah's account of the story of Bil'am (Num. 22:2-25:25). The Moabite king Balak is cognizant of Bil'am's capabilities as a master conjurer and recruits him to curse the nation of Israel. According to the current suggestion, when not receiving *nevu'ah*, Bil'am's mind operates within the confines of the *Radla* (point X in Fig. 1), on par with the rest of humanity. As such, his option to curse (or bless) Israel may be exercised as he sees fit. Not so when Bil'am is made recipient of Divine prophecy; throughout the narrative the Torah indicates (and Bil'am himself acknowledges) that his power to choose a course of action is abrogated for the duration of the prophetic experience, and his activities are compelled to conform to the Divine plan. The analogous mechanistic explanation would argue that permeation of the *Radla* membrane (point Y in Fig. 1), when it is enabling prophetic instruction, interfaces with and subjugates Bil'am's will to the singular design accruing from a Divinely-inspired "collapse of the universal wavefunction"—a state incompatible with personal agendas and autonomy.

V. Conclusion

We have attempted in this essay to demonstrate that the operations of the Radla as described in the Zohar and in the major works of the *Arizal, Ramḥal*, and other Kabbalistic luminaries bear suggestive and thought-provoking similarities to Heisenberg's uncertainty principle, a pillar of quantum mechanics. Viewing these homologies in juxtaposition, we illustrated how they may inform our understanding of several fundamental cosmological principles, including the very fabric of Creation,

the translation of indeterminacy into experiential reality and the intrinsically paradoxical, but ultimately unified, nature of the physical universe. Finally, possible implications of the quantum/*Radla* paradigm for epistemology and prophecy were considered.

In short, two highly counterintuitive systems—one rooted in rigorous scientific experiment and the other in mystical thought—exhibit a striking convergence in their description of certain fundamental aspects of existence. One might ask: What is the value of this exercise in comparative analysis? As we noted at the outset, many philosophers, historians, scientists, and of course many of the religiously committed, become fascinated by comparisons of this nature for a variety of reasons. The physicist Joel Primack and the historian of science Nancy Ellen Abrams have emphasized one important dimension, albeit they deal with cosmology rather than QM. They were inspired to proclaim the following:

> We will turn to Kabbalah, medieval Jewish mysticism, as a possible source of language and metaphor, because certain kabbalistic concepts fit our picture amazingly well. Moreover, Kabbalah's cosmology gave meaning and purpose to the everyday lives of its adherents, which we hope may become possible with the scientific cosmology emerging today.[56]

The material presented in this article should be construed as a work in progress, one which has left many questions unanswered or only partially addressed. We hope that we have articulated the homologies between quantum physics and the Kabbalah in a balanced manner—refraining from leaps even while insisting on certain commonalities—and that this project will serve as a stimulus for further reflection and research on what we think is an intriguing way of relating Torah and *Madda*.

56. Primack and Abrams, "In A Beginning" http://physics.ucsc.edu/cosmo/primack_abrams/InABeginningTikkun1995.

Acknowledgments

The authors gratefully acknowledge Professors Charles Townes, Howard Smith, and Ira Robinson, and the editor, editorial assistant, and anonymous referees for *The Torah u-Madda Journal* for their insightful comments concerning various aspects of this work.

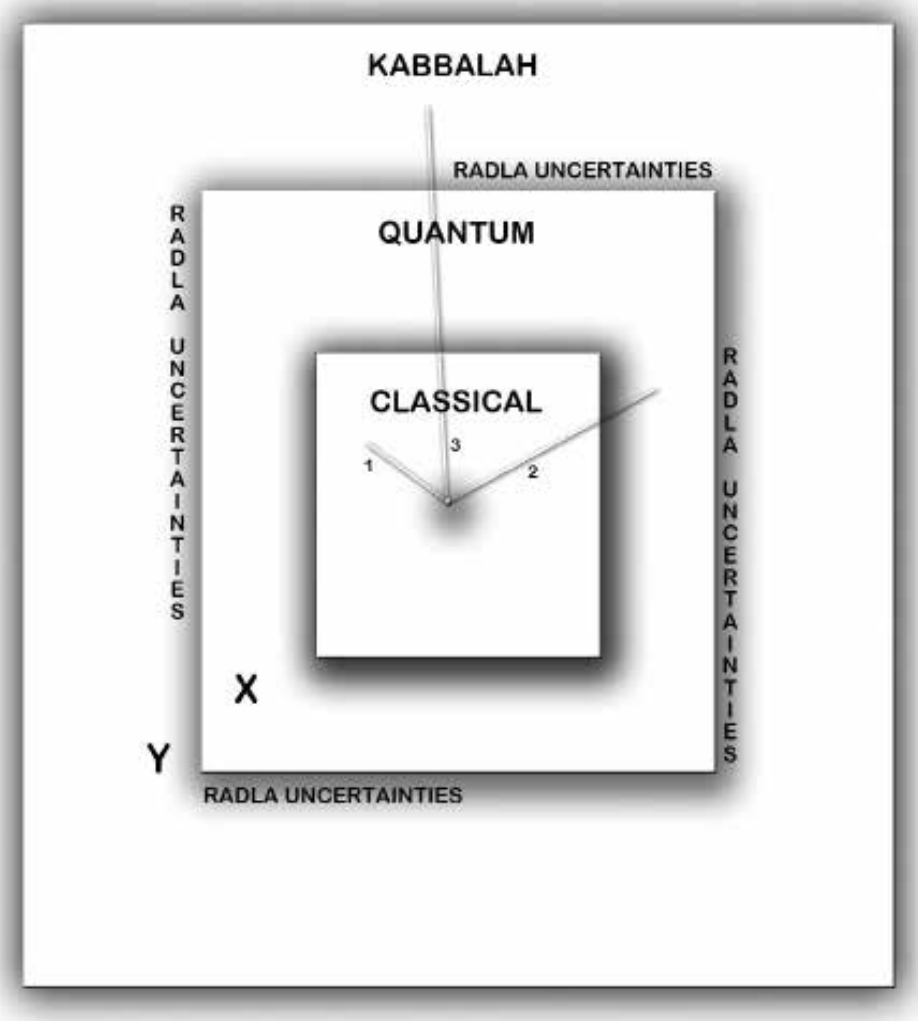

Fig. 1 (See p. 149)