# The Holomorphic Quanta

## Part 1: Separation

Theodore St. John
*stjohntheodore@gmail.com*

> *If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes.*
> *Albert Einstein, (1879 - 1955)*

## Abstract

Quantum Mechanics is appropriately named because it is mostly about the mechanics used to work probability problems applied to quantum particle-waves. In this paper I propose a better way to visualize the quantum domain – a vector model that reveals how it relates to the relativistic domain and provides a better conceptual interpretation of both. I offer a solution by graphically mapping the relationships between space, time and motion but interpose the linear space-time domain with the inverse spatial-temporal *frequency* domain to produce an energy diagram. This approach demonstrates the equivalence of space and time as $S = Tc^2$, and reveals the equations for energy of a quantum particle in terms of frequency in exactly the same geometric relation as the total energy relations that include mass-energy equivalence. The model focuses on energy as a characteristic (like color or form) and allows one to visualize the particle-wave duality problem as a change in perspective – the same as you would when you visualize an object from two different perspectives – at rest with respect to your classroom yet in motion with respect to the sun. As an analogy, I refer to these perspectives as icons and windows that we can click on to switch our focus from one domain to another.

The result of this process revealed some very important patterns and clues that I follow in parts 2 and 3 where I show how the model inherently contains the Klein-Gordon equation, Schrodinger's equation, quantum numbers, the Golden Ratio, the fine-structure constant and spatial frequency gratings necessary to identify quantum particles as holomorphic images.

## Introduction

The Copenhagen interpretation of quantum physics has been, and still is the most widely accepted explanation of quantum phenomena. Treating the quantum wave function as a probability wave is simple and accurate, so there doesn't seem to be a need to fix it. However, in a recent study on the effectiveness of teaching and learning quantum mechanics, it was found that there are significant misconceptions and a variety of mixed interpretations of quantum concepts. (Krijten-Lewerissa, et al. 2017) The study also concluded that the most effective teaching methods placed emphasis upon visualization and conceptual understanding, and that this approach has made it possible to introduce quantum mechanics at an earlier stage. But visualization means "the formation of a mental image of something," so if the concept that you are trying to understand has no form, it is impossible to visualize without appropriate analogies. The challenge for the teacher is to give it form or at least some kind of structure without creating the classical misconceptions.

We are told that you cannot understand a "wave packet" the way you can understand a particle or a wave, both of which have form, because a quantum is neither a particle nor a wave – it is both. So there seems to be no form or structure to visualize. Mathematicians may be perfectly comfortable visualizing groups of matrices, but that is very unsatisfying to some. So rather than trying to visualize the quantum, or memorize matrices, some teachers have us settle for visualizing a series of mysterious boxes (or even meat grinder analogies) (Morrison 1990, 5) that have inputs and outputs, temporarily ignoring what happens inside the boxes[i]. This is a little more satisfying because, even though we don't fully understand the quantum, we feel like we understand the ***process***. And it's the process that really matters to us. When you calculate trajectory, it doesn't matter if you throw a golf ball or a spherical cow; the process is the same, only scaled differently. And the nice thing about processes is that they can be represented by graphs. Graphs provide that satisfying image that you can wrap your mind around and *see* how one concept relates to another.

But there is a catch. A graph is a coordinate system and the image plotted on the graph is a *map* that represents a concept that includes a process, not just the icons on the map. It is not a picture. This is a very important distinction. Failing to recognize this distinction is a stumbling block for many undergraduate (and some graduate) physics students. Perhaps it's because we learn to use the Cartesian coordinate system in Physics 101 to plot a projectile's vertical height ($y$) versus horizontal distance ($x$), in which case the map looks exactly like the picture. In that case, the intersection of $y$ with $x$ is an actual location, so it is easy to think that the axes actually cross. But a plot of vertical height versus *time* also looks exactly like the picture, so it's hard not to *think* that the $t$ axis actually intersects the $y$ axis. The problem here is that it creates "the zero point problem", i.e. the false representation of zero space and zero time that leads to singularities and infinities. And the distortions common in maps can lead to distorted interpretations if we don't account for the difference in domains.

This presentation is organized into four parts, to mimic four steps in a process that is an underlying theme of the paper. These steps are 1) separation, 2) projection, 3) reflection, and 4) reintegration.

In part 1, we use the graph to visually represent the relationships between space, time and motion. That, in itself, is not different from classical physics, but in this paper I eliminate the distortions caused by the zero-point problem by interposing the first increment of the linear space-time domain (the moving or relativistic reference frame in the region greater than one) with the inverse or *frequency* domain (the at-rest, center-of-mass, or quantum reference frame in the region between zero and one). This composite diagram presents motion (a dualistic form of energy) as the fundamental process, with space and time as different aspects of motion conceptually separated into orthogonal dimensions used for mapping the *image* of motion.

The resulting diagram

1. demonstrates space-time equivalence $S = Tc^2$: exactly the same relation as $E = mc^2$
2. makes the zero-point problem a non-issue (no singularity) yet allows for zero-point energy,
3. reveals the relativistic equations for energy of a quantum particle as two components (base vectors) of a quantum wave function (a composite space-time vector).
4. allows one to visualize the particle-wave duality as a *duality in perspective* of a non-dualistic whole, the same as you can visualize an object both at rest yet simultaneously in motion with respect to a moving reference, and
5. recognizes the background as being an integral part of the whole quantum particle, giving it the potential to be seen as either a stationary object (particulate form) or as an integral part of the entire moving universe.

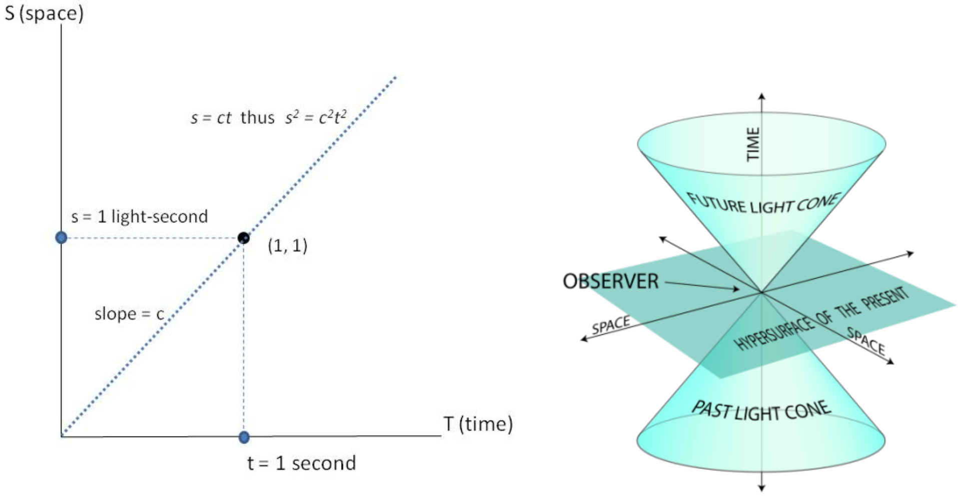
# The Space-Time-Motion Diagram

## Minkowski space-time

To set up the visual model, we begin with the Minkowski space-time ($ST$) formalism, which was used by Einstein to illustrate spacetime as a four-dimensional continuum in a graph of space ($S$) versus time ($T$) as in Figure 1a. We imagine a flash of light at the origin that expands spherically outward in space ($S = s^2 = x^2+y^2+z^2$) at the speed of light $s^2 = c^2t^2$, or $S = CT$, represented by the diagonal line (with $C = c^2 = 1$ in "natural units") from the origin. So when the clock ticks 1 second, (a *coordinate point* on the $T$ axis), the surface of the light sphere (a coordinate on the $S$ axis) is moved outward 1 light-second.

Note that upper case $S$ and $T$ are used here to mean the *modulus* of space and time, where $S = s^2$ and $T = t^2$ are “square spaces” meaning that they require at least 2 dimensions to describe them. $S$ and $T$ are always positive, but neither are directly measurable. Lower case $s$ represents the radius of the light sphere and therefore, the distance that the surface of the sphere travels in a given amount of time, also as one positive increment - lower case $t$. Both scalars are also positive but unlike $S$, the scalar, $s$, is measurable as one dimension – radial distance. And unlike $T$, a unit of $t$ means a quantified unit of time. These are important distinctions that will be discussed further to clarify some misconceptions.

In Figure 1b the axes are rotated to show the Minkowski diagram as it is normally presented. It is important to emphasize that $s = ct$ represents the radius as a single dimension that increases with time as a single dimension. But Minkowski treats time in the classical manner, as if it is actually one-dimensional – independent of space – so he uses $t$, which is $\pm\sqrt{T}$ and claims (*a priori*) that the negative axis represents the “past”. Then he tries to represent 3D space on the same diagram. But 3D space cannot be represented as three dimensional in the diagram, so it is portrayed as a “hypersurface” of the present. At this point, the ability to visualize the relations with angles on the graph has failed.



a. b.

**Figure 1** **(a) A plot in natural units (c=1) of space vs. time that illustrates that light travels one unit of distance (light-second) in one unit of time (second) (b) Minkowski’s time vs. space diagram is normally shown with time as the verticle axis and space as a horizontal plane. The time axis is mirrored to represent the past as negative time and the future as positive time. However the ability to visualize the relations with the graph has failed since space is represented as a 2D “hypersurface of the present”.**

The intersection of the time axis with this “hypersurface” is said to represent an event, i.e. the present at $t = 0$ creating the zero point problem, a singularity. Then the equation ($s^2 = c^2t^2$) is expanded on one side to give ($x^2+y^2+z^2 = c^2t^2$) and rearranged to give the four-dimensional spacetime manifold $x^2+y^2+z^2 - t^2 = 0$, with $c = 1$. No physicist or mathematician would blink an eye at the equation that describes a spherical expansion of light ($s^2 = c^2t^2$), written as ($x^2+y^2+z^2 = c^2t^2$). It is mathematically correct, because the equation for a sphere is $S = s^2 = x^2+y^2+z^2$ and everyone knows that time must be treated as one scalar dimension. So time is treated as the forth element of a quaternion and progress in mathematical physics continues to grow in complexity. But some physicists admit that it has hit a wall (Smolin, The Trouble with physics 2006) (Tong 2017). The obstacle, I submit, is that nobody really knows what time is. There are several different opinions about the meaning or essence of time, but until it is understood, it is either treated classically or as something that somehow mixes with space to give us space-time. (Barbour 1999) (Burtt 2003) (Hawking 1990) (Smolin 2013).[ii]

## Symmetry of space and time

In this paper, as in Burtt's *Metaphysical Foundations of Modern Science* (Burtt 2003), time is considered to be nothing more than a standardized measure of motion. (St. John 2014). Burtt said,

> *"Clearly, just as we measure space, first by some magnitude, and learn how much it is, later judging other congruent magnitudes by space; so we first reckon time from some motion and afterwards judge other motions by it; which is plainly nothing else than to compare some motions with others by the mediation of time; just as by the mediation of space we investigate the relations of magnitudes with each other."*

If time is a measure of motion, you cannot treat time as one-dimensional while treating space as three. Motion in space ***is*** motion in time and vice versa (like sand through an hour glass or motion of the sun). They are equivalent yet different characteristics of the same essence. If the term for space (radius of the sphere) is unfolded to represent three orthogonal dimensions, then the same must be done for time, as $s^2 = x^2+y^2+z^2 = c^2(t_x^2 + t_y^2 + t_z^2)$. If not, then they both must be kept enfolded. Writing the equation $s^2 = c^2t^2$ as

$$\boldsymbol{S = Tc^2} \tag{1}$$

means that space and time are equivalent, just as

$$\boldsymbol{E = Mc^2} \tag{2}$$

means that energy and mass are equivalent. $C = c^2$ is just the conversion factor that comes from arbitrary units of measurement (meters, miles, seconds, light-years, etc). In natural units, it is just 1.0.

## The Inverse Problem

Consider the "Inverse problem," i.e. the multiplicative inverse of the equation $s = ct$, that is, $\frac{1}{t} = c\frac{1}{s}$. In terms of frequency, this is

$$f_t = cf_s \tag{3}$$

where $\frac{1}{t} = f_t$ is temporal frequency and $\frac{1}{s} = f_s$ is spatial frequency. And when plotted on a space-time diagram, as shown in Figure 2, *c* represents the exact same line as in Figure 1a.

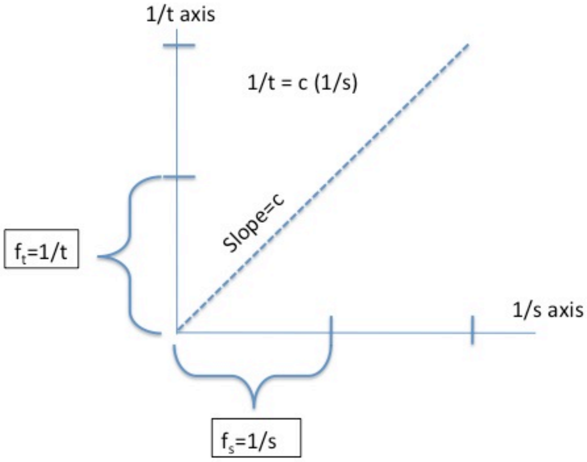


**Figure 2 The Inverse Problem: Inverse time versus inverse space $\frac{1}{t} = c\frac{1}{s}$, is the same as temporal frequency versus spatial frequency or $f_t = cf_s$.**

Even if we don't have a clock to represent the passage of time, this plot represents temporal frequency of the light sphere versus spatial frequency. Combining these two plots will provide an improved model (with more information) if we use both sets of axes to scale the same diagonal line, *c*. But notice that the spatial and temporal axes are flipped in Figure 2 as compared to Figure 1a. So the vertical axes represent different domains and there is only one point on either axis that is numerically equal, that is at the first increment, i.e. 1 unit. That is not a problem because that is how we always make graphs, – like S vs. T is constructed by intersecting them where they are numerically equal to zero. We call it the origin. It is actually just a reference point.

So with the two domains superimposed, the first increment on the vertical axis represents the frequency of the sphere of light (say one unit of blue, for example, which we know is 637 THz) *and* the radial distance that the light travels in one increment of time, in whatever units you choose. Since $E = hf$, it also represents the energy of the sphere, scaled by Planck's constant, *h*, as a quantum particle, see Figure 3.

We don't really need the horizontal axis for a model since we have both space and time represented in the vertical axis. It wouldn't be very useful as a visual tool because the only point that matters is 1, so at $t = 1$ you just imagine the vertical axis unfolding into 3 dimensions and visualize a sphere and reset the scale. In 1 attosecond, it is the size of 2 hydrogen atoms in radius and in 1 second, its $3\times10^8$ meters. The same diagram (space-time with no motion) represents a quantum regardless of what time does, like the time-independent wave function. So if you wanted to use it, you also have to reset the time scale so that for each measurement event the time unit becomes a new $t_1$ and the previous event, $t_o$, gets moved in toward $t = 0$.

That's an important point that will be useful in part 3 of this paper. It is the scale that changes when we make an observation, not the energy. You have to mentally and visually adjust the scale of the background to see the correct picture. Nothing happens to the particle. Without the horizontal axis, this space-time-with-no-motion diagram has no practical use, but it illustrates symmetry and how measurement events break symmetry, collapsing time to zero. Adding the horizontal axis, call it the Space-Time-Motion (STM) diagram, is more useful as a visual tool, especially since it adds *chirality*, meaning that it can be distinguished from its mirror image. But it creates another scale on the map that distorts the visual image. So you have to be very careful how you use it to interpret the meaning of the plot. I will use it to demonstrate how that has happened in physics.

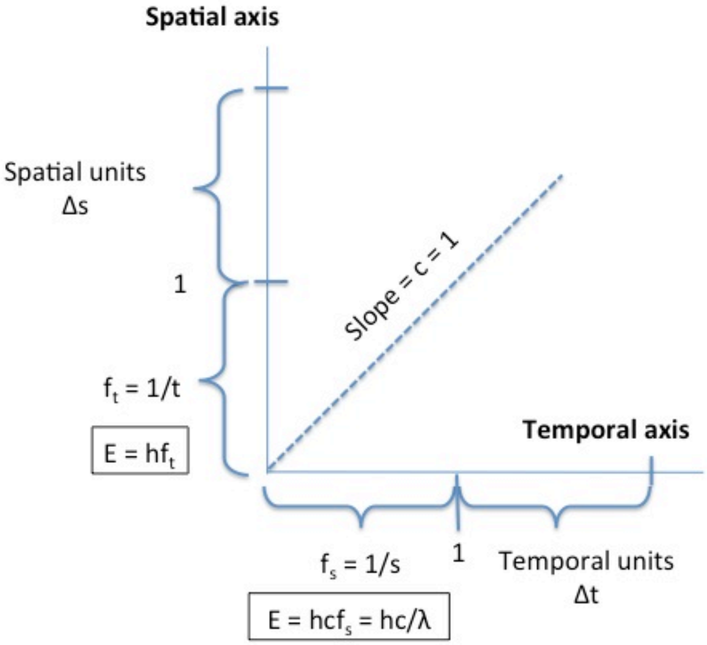


**Figure 3 The inverse temporal domain scaled by Planck's constant is the energy of a quantum unit.**

## Quantum Energy in the STM Diagram

Now because $f_t = \frac{1}{t} = c\frac{1}{s}$, the same energy can be written as $E_t = hf_t = hc\frac{1}{s}$. Substituting wavelength, $\lambda$, for $s$, we get $E_t = hcf_s = hc\frac{1}{\lambda} = E_s$ to scale the horizontal axis. These are the two equations for energy of a quantum particle, $E = hf$ and $E = pc$, where $p = \frac{h}{\lambda}$ is the momentum. Figure 3 represents the domain of a quantum particle on a background scalar domain, so it is time-dependent. I labeled the two domains as if they are separate, but they both span they entire line. This ambiguity is resolved by representing the energy domain with vectors. The direction of the vector arrow must be outward because the sphere of light is expanding outward in space and in time in reference to the scalar background. And since they represent the quantum unit of energy, their magnitude is one, so they are unit vectors by definition. Therefore they are shown in Figure 4 as base vectors.

They are called "state vectors" in Hilbert space, a sort of *hyperspace* used in quantum mechanics. I use the word hyperspace to mean that it includes domains beyond (ergo hyper) the standard 3D space using the same rules as vectors in 3D space. It doesn't mean that there are other mind-blowing parallel universes and it is not the notional space-time continuum in which it is theoretically possible to travel faster than light or back in time popular in science fiction. And in order to avoid crossing the boundary between science and science fiction, as some physicists and mathematicians have done[iii], think of dimensions in Hilbert space (including scalar space and vector space) like computer windows that are hyperlinked at boundaries or icons. Figure 4 shows two windows (quantum energy inside the arc and the background scalar plot outside the circle) on the STM diagram.

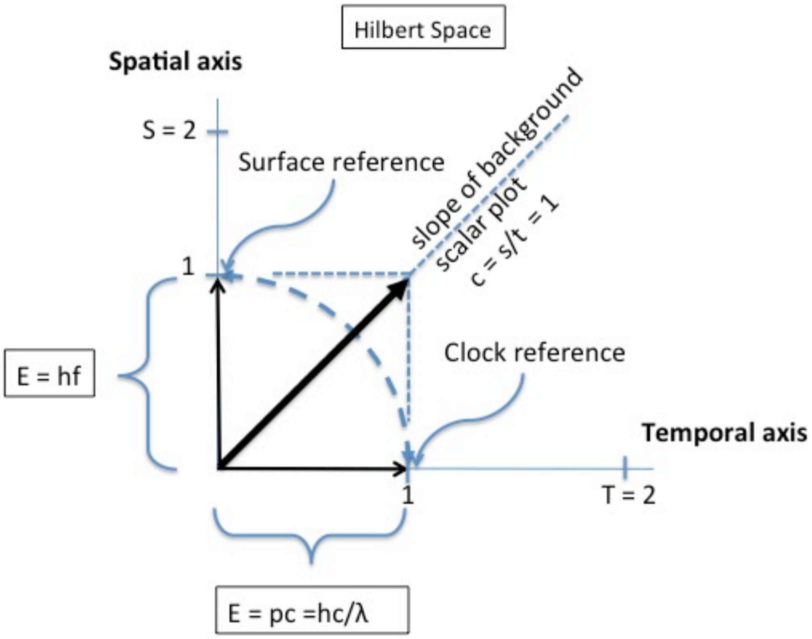


Figure 4 The inverse-time or frequency axis scaled to units of *h* reveals the deBroglie relations for energy. Since they are both quantum units, they are represented as base energy vectors in Hilbert space.

The base vectors are icons in the energy domain and the tips of the vectors, where the boundary conditions are satisfied, are hyperlinks to the scalar domain. In part 2, I will discuss how the use of vectors results in distortions (as expected in mapping operations) as they are projected out of one domain into another, and how this can cause interpretations to be distorted as well.

## Conclusion

By recognizing space and time as equivalent measures of energy (motion), we can interpret the quantum particle as the form-characteristic of energy. There is nothing weird about the particle-wave duality; it is simply the duality of perspectives – a morphological illusion that can be visualized by analogy with computer windows, hyperlinks and avatars.

## Bibliography

Baggott, Jim. *Farewell to Reality. How Modern Physics Has Betrayed the Search for Scientific Truth .* Kindle. Pegasus Books, 2013.
Barbour, Julian. *The End of Time: The Next Revolution in Physics.* Kindle. Oxford University Press, 1999.
Bohm, David. *Wholeness and the Implicate Order.* 1980.
Burtt, E. A. *The Metaphysical Foundations of Modern Science.* Mineola, NY: Dover Publications, 2003.
Carlström, Stefanos , Johan Mauritsson, Kenneth J Schafer, Anne L'Huillier, and Mathieu Gisselbrecht. "Quantum coherence in photo-ionisation with tailored XUV pulses." *J. Phys. B: At. Mol. Opt. Phys.* 51 (2018).
Germine, Mark. "The Holographic Principle of Mind and the Evolution of Consciousness." *World Futures* 64, no. 3 (2008).
Grof, Stanislav. *The Holotropic Mind.* New York: HarperCollins Publishers Inc, 1993.
Halliday, David, Robert Resnick, and Jearl Walker. *Fundamentals of Physics, Fourth edition, Extended.* John Wiley and Sons, Inc, 1993.
Hawking, Stephen. *A Brief History of Time; From the Big Bang to Black Holes.* New York: Bantam Books, 1990.
Hestenes, David. "Oersted Medal Lecture 2002: Reforming the Mathematical Language of Physics." *Am. J. Phys.* 71, no. 2 (Feb 2003): 104-121.
Kreyszig, Erwin. *Advanced Engineering Mathematics.* 4th. New York: John Wiley and Sons, 1979.
Krijten-Lewerissa, K., H. J. Pol, A. Brinkman, and W. R. van Joolingen. "Insights into teaching quantum mechanics in secondary and lower undergraduate education." *Phys. Rev. Phys. Educ. Res* 13, no. 010109 (Feb 2017).
Mantz, Christiaan L. M., and Tomislav Prokopec. "Resolving Curvature Singularities in Holomorphic Gravity." *Found. Phys.* 41 (2011): 1597-1633.
Morrison, Michael A. *Understanding Quantum Physics: A User's Manual.* New Jersey: Prentice Hall, 1990.
Pribram, Karl. "The Holographic Hypothesis of Brain Function: A meeting of minds." *Karl Pribram.* 1984. http://www.karlpribram.com/data-papers/ (accessed 2018).

Science Daily. "Electron Gets Film Debut In First-ever Video Of Its Kind." *Science News From research Organizations.* https://www.sciencedaily.com/releases/2008/02/080222095358.htm (accessed Apr 25, 2018).
Shanahan, Daniel. "A Case for Lorentzian Relativity." *Foundations of Physics*, Sep 2014: 21.
Smolin, Lee. *The Trouble with physics.* Boston: Houghton Mifflin Company, 2006.
—. *Time Reborn: From the Crisis in Physics to the Future of the Universe.* Kindle. Houghton Mifflin Harcourt, 2013.
St. John, Theodore. "The Unity of Space and Time." *viXra.* 2014. http://vixra.org/abs/1401.0218.
StJohn, Theodore. "The Space-Time-Motion Model." *viXra.* 2014. http://vixra.org/abs/1402.0045.
Suskind, Leonard. "The World as a Hologram." *Journal of Mathematical Physics* 36 (1995): 6377.
Talbot, Michael. *The Holographic Universe.* New York: HarperCollins, 1991.
Tong, David. "Quantum Fields." *The Royal Institution.* Cambridge, Feb 15, 2017.
Various. "How valid is Milo Wolff's Space Resonance/Wave Structure of Matter Theory? ." *Quora; Physics.* Sep 2, 2013. https://www.quora.com/How-valid-is-Milo-Wolffs-Space-Resonance-Wave-Structure-of-Matter-Theory-Does-WSM-supplant-Quantum-Mechanics-as-Wolff-and-de-Broglie-before-him-suggests-Is-it-a-candidate-for-GUT (accessed 2018).
Wolff, Milo. "The Wave Structure of Matter." 2006. http://wsminfo.org/index.htm (accessed 2018).

---

[i] Many other visual tools are memory aids, such as visualizing electron configurations as suites inside apartments on floors of an apartment building. These are training tools that are great for technicians and mechanics, but not for understanding.

[ii] Physicist Lee Smolin considers *the time problem* to be "the single most important problem facing science as we probe more deeply into the fundamentals of the universe." (Smolin, Time Reborn: From the Crisis in Physics to the Future of the Universe 2013)

- Newton's idea of absolute time and space –as independent and separate aspects of objective reality, and not dependent on physical events or on each other and independent of any perceiver – was superseded by Einstein who showed that a single event does not happen simultaneously to two observers moving relative to each other. So in relativistic physics, time is considered one of four dimensions of spacetime. But in quantum physics, position and time are considered separate, independent quantities. (Morrison 1990, 58)
- Physicist Julian Barbour said, "Time does not exist. All that exists are things that change. What we call time is – in classical physics at least – simply a complex of rules that govern the change." (Barbour 1999, Loc 2327)

---

- Stephen Hawking stated that time exists, but is comprised of a real and imaginary component. "Imaginary time is indistinguishable from directions in space." Thermodynamic and cosmological time are real – they describe the increase in entropy of the universe, which started with the big bang and provide the arrow of time that points in the same direction as the expanding universe. (Hawking 1990, 143-155)
- And Lee Smolin says that time is real. "Embracing time [as real] means believing that reality consists only of what's real in each moment of time. Whatever is real in our universe is real in a moment of time, which is one of a succession of moments." (Smolin, Time Reborn: From the Crisis in Physics to the Future of the Universe 2013, Loc 80)

[iii] I concur with Jim Baggott's opinion, expressed in his book, Farewell to Reality: How Modern Physics Has Betrayed the Search for Scientific Truth (Baggott 2013), that many of the interpretations in modern physics, especially Cosmology, are either cop-outs (like the big-bang) or ideas that resemble science fiction – what Baggott calls fairy tales.