De Broglie and Bohm

Making Waves in Quantum Physics

Joshua J. Wilson

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Louis-Victor-Pierre-Raymond de Broglie
Born: August 15, 1892, Dieppe, France
Died: March 19, 1987 (age 94)
Louveciennes, France

David Joseph Bohm
Born: December 20, 1917, Wilkes-Barre, Pennsylvania, US
Died: October 27, 1992 (aged 74)
London, England, UK

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Abstract: This paper explores the pilot wave theory of de Broglie (deh broh-yee) which gives explanations for the movement of particles along a wave, and provides a hypothesis for the distribution of particles as demonstrated in the double-slit experiment. De Broglie presented his theory at the 1927 Solvay conference where it was rejected, whereupon de Broglie abandoned the theory. However, the theory was rediscovered and extended in 1952 by physicist David Bohm. The principles of the theory are realistic (meaning that its concepts exist independently of the observer) and deterministic, that events are bound by causality in such a way that any state of an object or event is determined by prior states. These principles are contrasted in this paper with the probabilistic Copenhagen interpretation of physical systems and quantum mechanics. Part two considers the idea of gravity as a universal information matrix.

The human interest side of these two men's lives and their philosophies are examined revealing compelling qualities that, to me, illuminate the way forward in science and physics as clearly as any I have studied on these subjects.

Part One

Pilot wave theory debut

The International Solvay Institutes for Physics and Chemistry, located in Brussels, were founded by the Belgian industrialist Ernest Solvay in 1912, following the historic invitation-only 1911 *Conseil Solvay*, considered a turning point in the world of physics.

Photograph of the first conference in 1911 at the Hotel Metropole. *Seated* (L-R): W. Nernst, M. Brillouin, E. Solvay, H. Lorentz, E. Warburg, J. Perrin, W. Wien, M. Skłodowska-Curie, and H. Poincaré. *Standing* (L-R): R. Goldschmidt, M. Planck, H. Rubens, A. Sommerfeld, F. Lindemann**, M. de Broglie,** M. Knudsen, F. Hasenöhrl, G. Hostelet, E. Herzen, J.H. Jeans, E. Rutherford, H. Kamerlingh Onnes, A. Einstein and P. Langevin.

L. de Broglie is seated third from right, middle row (colorized photo)

Louis de Broglie presented his pilot wave theory at the 1927 Solvay Conference where it encountered a chilly reception. Wolfgang Pauli raised an objection that de Broglie was able to counter, but it seemed that the audience was lost in the details and de Broglie's mild manner. The objection was, however, successfully countered decades later. Niels Bohr and Werner Heisenberg emerged victorious from the conference with their uncertainty principle, later called the Copenhagen interpretation. It is, to me, a sad note that de Broglie abandoned his theory so quickly as a result, but he was a gracious man. He said he was, "discouraged by the criticisms it aroused." [Louis be Broglie, in the foreword to David Bohm's *Causality and Chance in Modern Physics* (1957). p. x.]

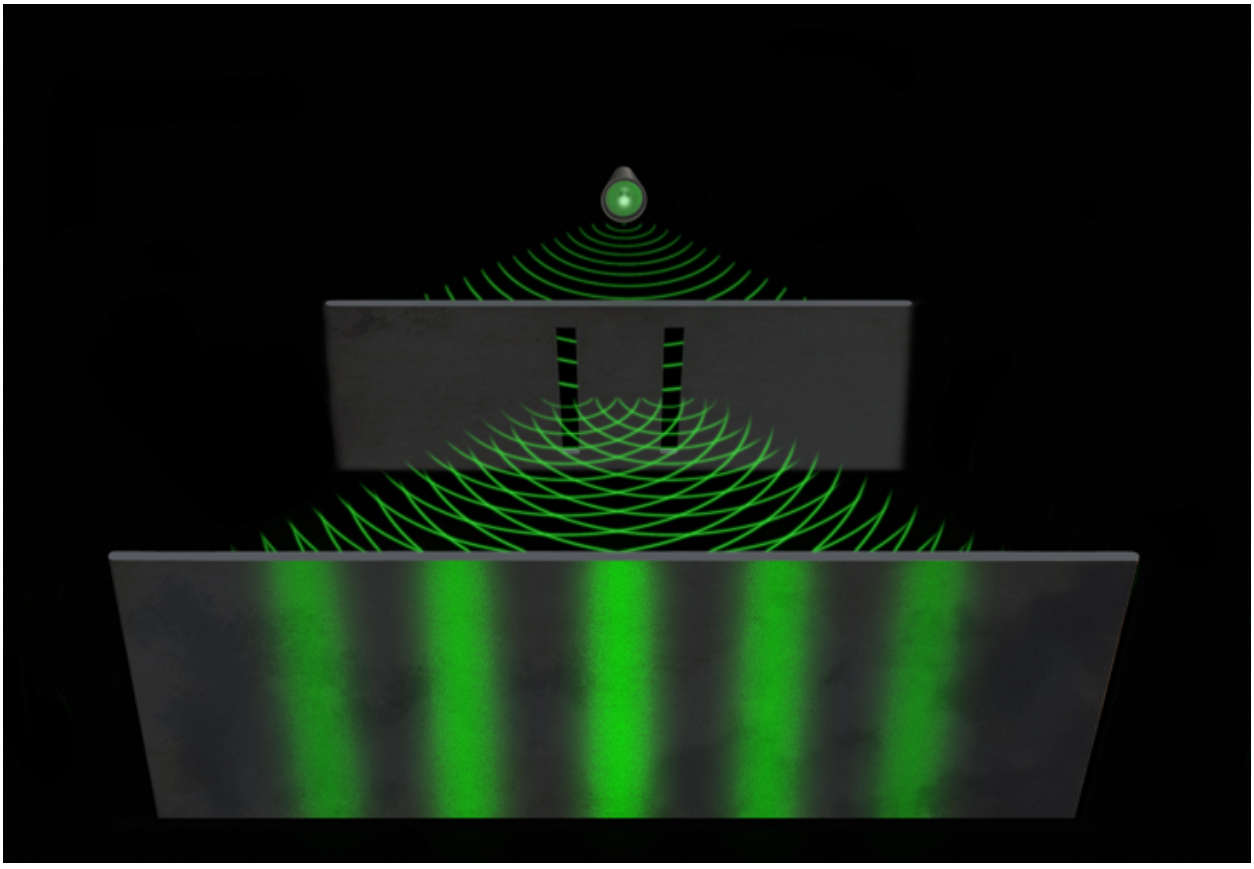
It would take twenty-five years for it to be independently (re)discovered by David Bohm. However, I was happy to learn that de Broglie evidently felt more free to return to his earlier findings later in his life when the atmosphere had become less doctrinaire. In his 1967 television interview (he was 74 years of age) de Broglie, when questioned on this subject said, "But I think today we have been too far in that (probabilistic) direction and that in reality, the uncertainty principle is only 'an uncertainty principle.'" In the context of that interview I take his meaning to be that the Heisenberg uncertainty principle is, itself, uncertain. This contest of ideas is explained in detail in this essay.

The Double-Slit Experiment

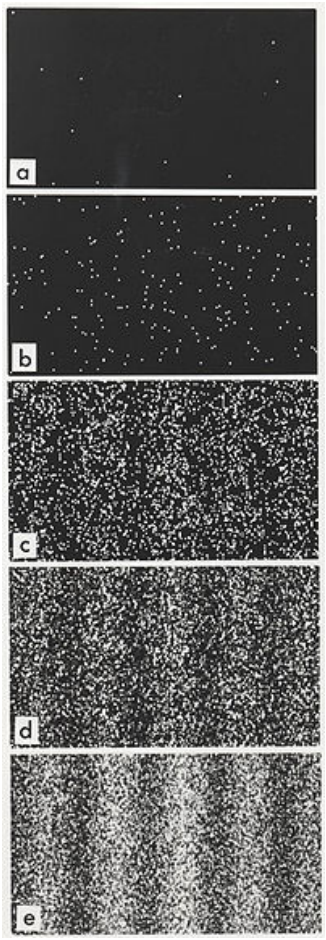
The double-slit experiment is the starting point and the fulcrum from which we may understand the principle viewpoints regarding the movement of particles, such as photons, electrons, and even molecules through space. It is also the position from which the two major competing science

theories on the subject—the Copenhagen interpretation and the Pilot Wave thesis—can be compared and contrasted.

The experiment setup is as follows: A barrier with two slits, or openings, is positioned vertically. Behind the barrier is vertical surface that can detect incoming particles, such as a photographic sheet to detect light. In front of the barrier is a device which emits radiation. The patterns of the particles meeting the receptor behind the barrier are observed.

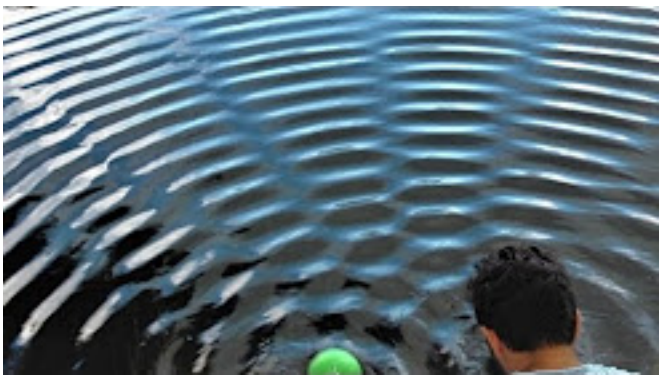


Double slit experiment with green light (center band is brightest)



Electron build-up from electrons passing through double slits over time (center band is brightest)

Here is an entertaining video of a science guy demonstrating the double-slit experiment made from a cardboard box to folks outdoors in a park.



https://youtu.be/Iuv6hY6zsd0

This paper progresses from the visual, to the entertaining, to the educational, and finishes with the provocative, deep and important issues regarding the way our universe of space, energy-matter, and time operate. It is necessary for you to first understand the basic operation and results of the

famed double-slit experiment before we may discuss the profound implications of this phenomenon that a PBS science commentator described as "the quantum experiment that broke reality." Actually, I'm sure that reality was not broken or even bent, but the wobbling Copenhagen interpretation is ceding ground quickly to current research and discovery.

You may have thought light passing through two slits would produce two bands of light, as did many of the passersby in the above video. Hopefully now you're perceiving that something quite different is occurring. The *reason* why the characteristic, reliable interference patterns are created by this experiment is what has the best minds in physics debating among themselves and looking for answers.

The Copenhagen interpretation

Niels Bohr operated his physics institute in Copenhagen, Denmark, and during the 1920s Werner Heisenberg was his assistant. Heisenberg coined the term "Copenhagen interpretation" but later privately expressed regret on using the term because he felt that to give his view a name implied that there could be other interpretations, which he did not believe possible, as shown below. I find his hubris quite humorous! This makes me thankful I live in a later century when science has a better opportunity to learn and grow.

> Heisenberg said, "I avow that the term 'Copenhagen interpretation' is not happy since it could suggest that there are other interpretations, like Bohm assumes. We agree, of course, that the other interpretations are nonsense, and I believe that this is clear in my book, and in previous papers. Anyway, I cannot now, unfortunately, change the book since the printing began enough time ago." [Olival Freire Jr., "Science and exile: David Bohm, the hot times of the Cold War, and his struggle for a new interpretation of quantum mechanics", *Historical Studies on the Physical and Biological Sciences*, Volume 36, Number 1, 2005, pp. 31–35.]

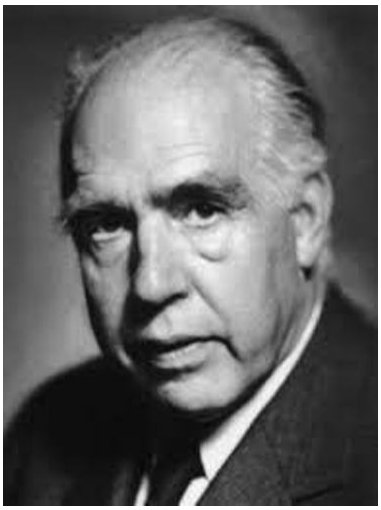
A proper treatise on the Copenhagen interpretation would require considerable space to adequately cover, so my apologies for being brief. Its tenets involve the following:

- Things are both waves and particles at the same time
- The wave function is not a wave in anything physical, but an abstract distribution of probabilities
- The act of observation defines reality. Results are different if you are looking at them.

There are a number of philosophic and scientific critics of the Copenhagen interpretation, from E.T. Jaynes to Einstein who said,

> "I, at any rate, am convinced that He (God) does not throw dice."[54] and "Do you really think the moon isn't there if you aren't looking at it?"[55] Niels Bohr, in response, said, "Einstein, don't tell God what to do."[56]
> [https://en.wikipedia.org/wiki/Copenhagen_interpretation]

This gives an idea of the high-level historical disagreements and serious problems with the Copenhagen interpretation, which really begs the questions, Why does it persist, and why is it still mainstreamed into some physics textbooks?




Niels Bohr, and Werner Heisenberg

The Bohr-Einstein debates were a series of public discussions between the two men. Despite their differences they remained friends and colleagues the rest of their lives. Niels Bohr made numerous important contributions toward understanding atomic structure, notably the Bohr model of the hydrogen atom, though primitive, but which made use of the quantum to explain the atomic spectrum of radiation emissions. The greatest problems and criticisms lie with Niels Bohr's and Heisenberg's theory of the effect of an observer upon an observed phenomenon. Also, their view on wave-particle duality represented an almost mystical approach. Einstein famously hated the idea of fundamental randomness. But in order to counter Bohr and Heisenberg it would require a full theory showing how a quantum object could show both wave- and particle-like behavior at the same time without being fundamentally probabilistic. That theory came from Louis de Broglie. More on that later, but first, let us finish with the Bohr-Einstein debates, during which the double-slit experiment was featured prominently:

> The quantum revolution of the mid-1920s occurred under the direction of both Einstein and Niels Bohr, and their post-revolutionary debates were about making sense of the change. The shocks for Einstein began in 1925 when Werner Heisenberg introduced matrix equations that removed the Newtonian elements of space and time from any underlying reality. The next shock came in 1926 when Max Born proposed that mechanics were to be understood as a probability without any causal explanation.
>
> Einstein rejected this interpretation. In a 1926 letter to Max Born, Einstein wrote: "I, at any rate, am convinced that He [God] does not throw dice."[5]
>
> At the Fifth Solvay Conference held in October 1927 Heisenberg and Max Born concluded that the revolution was over and nothing further was needed. It was at that last stage that Einstein's skepticism turned to dismay. He believed that much had been accomplished, but the reasons for the mechanics still needed to be understood.[4]
>
> Einstein's refusal to accept the revolution as complete reflected his desire to see developed a model for the underlying causes from which these apparent random statistical methods resulted. He did not reject the idea that positions in space-time could never be completely

> known but did not want to allow the uncertainty principle to necessitate a seemingly random, non-deterministic mechanism by which the laws of physics operated. Einstein himself was a statistical thinker but disagreed that no more needed to be discovered and clarified.[4] Niels Bohr, meanwhile, was dismayed by none of the elements that troubled Einstein. He made his own peace with the contradictions by proposing a principle of complementarity that emphasized the role of the observer over the observed.[3]
>
> [Wikipedia: https://en.wikipedia.org/wiki/Bohr–Einstein_debates, accessed January 19, 2017]

Niels Bohr and Werner Heisenberg were radicals who believed the challenges and strangeness of the newly discovered quantum mechanics allowed abandonment of classical physics when deemed required.

Enter David Bohm

If so formidable mind as Einstein's was not able to satisfactorily unseat the Bohr-Heisenberg axis, then that meant some passage of time and the arrival on the scene of such a physicist as David Bohm would be required. In my opinion, the solution to the above debates lay in Louis de Broglie's pilot wave theory, moldering since the 1927 Solvay Conference. His theory could be stated:

"Why not have real waves that push around real particles?"

This apparently had not occurred to the other Solvay attendees that such a wave could or even might exist. Therefore ever more extravagant explanations were required by Bohr-Heisenberg and their associates (continuing to today) to elucidate the qualities occurring during observation of phenomenon and the ensuing "collapse of the wave function," something which was never demonstrated empirically, but upon which their entire concept relied. Issues such as whether the observer was a human or a machine, issues such as whether the observer was being observed . . . continued to mount.

But the possibility *did* occur to physicist David Bohm. Louis de Broglie and David Bohm were *making waves* in the quantum science community. Bohmian mechanics provides for the idea that a particle moving through space creates a wave in the force fabric of space. In order to even begin a grasp of this idea one must consider the properties of space—the key factor, but one which was poorly understood in the mid 1900s. This particular lack constituted a void or vacuum in scientific research, and this *realistic* and *deterministic* void was filled, unfortunately, with *probabilistic* theories. The wave function does not collapse, as we shall see, but probabilistic theory is now collapsing instead.

Space is real, and space is not empty. It is filled with force presence, which can be referred to as the force blanket or force ocean of space, or as space pervaded by dark energy. This topic is covered in depth in my paper "Lemaitre and Einstein: A Day With No Yesterday" which you can read here:

Lemaitre and Einstein 10 Spark

Michael Faraday on Lines of Force

Due to the paucity of language the term "force" in physics and in general usage has a number of meanings and can be ambiguous. For the purposes of this essay we use the term to refer to the pre-energy charge pervading all space. For the sake of etymology, also, it is useful to review Faraday's use of the term, as he was the scientist who coined the phrase "lines of force."

Michael Faraday, 1842, by Thomas Phillips

> "According to J.J. Thomson, Faraday usually discusses *lines of force* as chains of polarized particles in a dielectric, yet sometimes Faraday discusses them as having an existence all their own as in stretching across a vacuum."
>
> **"Lines of force** originated with Michael Faraday, whose theory holds that all of reality is made up of force *itself*."
>
> "Unlike Faraday, Maxwell and others (e.g., J.J. Thomson) thought that light and electricity must propagate through an ether. (Also) In Einstein's relativity, there is no ether . . ."
>
> "The specific features of Faraday's field concept, in its 'favourite' and most complete form, are that force is a substance, that it is the only substance and that all forces are interconvertible through various motions of the lines of force. These features of Faraday's 'favourite notion' were not carried on." [https://en.wikipedia.org/wiki/Line_of_force]

Although Maxwell's "tubes of force," which have to do with electrical and electromagnetic propagation through an ether, are often referred to as synonymous with Faraday's "lines of force"

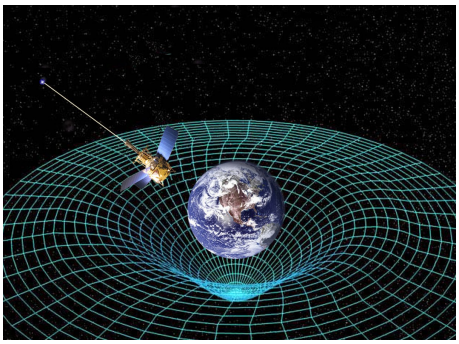
we can see from the above that this is not wholly the case. Faraday held a view of force as the intrinsic "substance" of space and his lines of force having an existence "all their own."

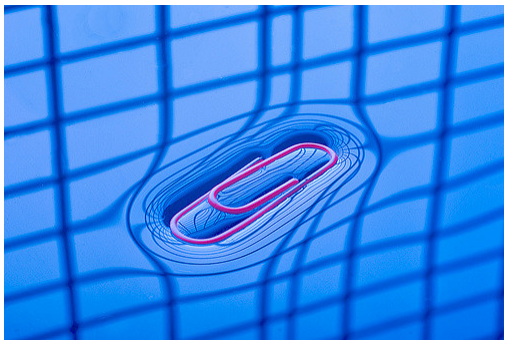
> "Albert Einstein kept a picture of Faraday on his study wall, alongside pictures of Isaac Newton and James Clerk Maxwell. Physicist Ernest Rutherford stated, "When we consider the magnitude and extent of his discoveries and their influence on the progress of science and of industry, there is no honour too great to pay to the memory of Faraday, one of the greatest scientific discoverers of all time." *[https://en.wikipedia.org/wiki/Michael_Faraday]*

Basic Particle and Wave Facts from the Bohmian Mechanics View

> "De Broglie–Bohm theory is a theory that applies primarily to the whole universe. That is, there is a single wave function governing the motion of all of the particles in the universe according to the guiding equation. Theoretically, the motion of one particle depends on the positions of all of the other particles in the universe." [https://en.wikipedia.org/wiki/De_Broglie–Bohm_theory]

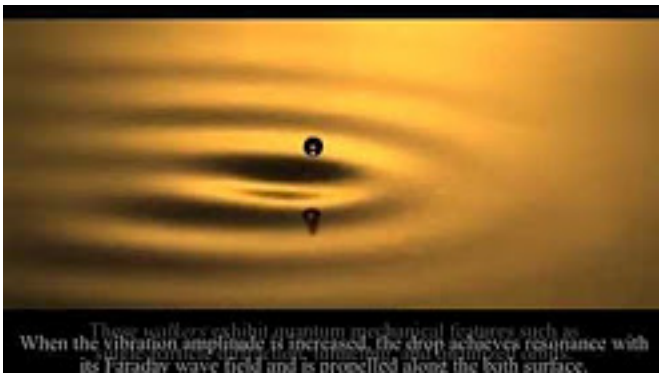
- Waveforms are created in space itself by the motion of particles through it
- Space and its pervasive force charge move to "make way" for entering particles





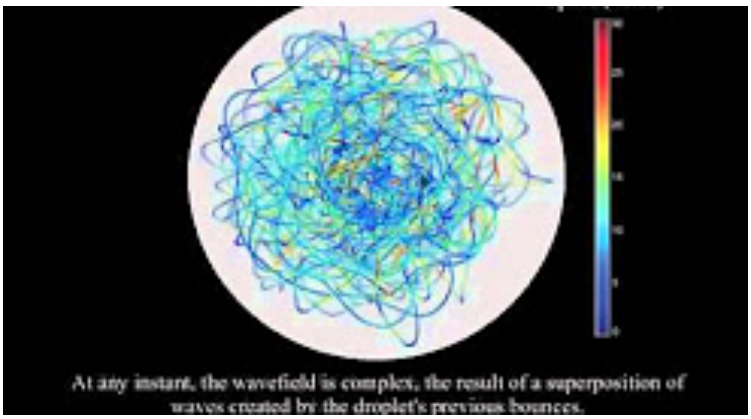
- A waveform of space force is created as a result of a particle moving through it
- The space-force wave created by a particle also pilots this same particle

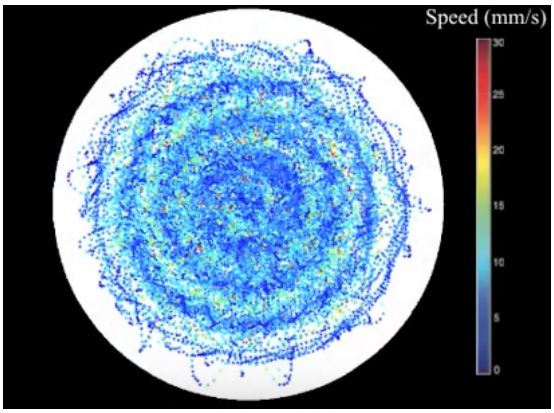
A recent experiment demonstrates pilot wave theory on the macro scale. A suspended oil droplet is seen to travel *along the wave it created*. This video also demonstrates the action of such walking oil droplets entering a double-slit arrangement. The same interference (intersection) pattern is created as seen in quantum experiments. Although macroscopic experiments cannot be assumed representative of microscopic phenomena, it is still interesting to note that things like this do occur in various levels in the material universe. You can view an informative, short video of this here:



https://youtu.be/WIyTZDHuarQ

The double-slit experiment is by no means the only one that demonstrates pilot waves. Another one demonstrates how particles bounce around in a circular corral, such as Faraday's corral. In the video below you can see a distribution of particle motion that appears random at first, but over time forms into three beautiful, non-random concentric circles (this is visible at 1:35 minutes into the video--the video begins with oil droplets and then segues to the corral experiment shown in the images below.)





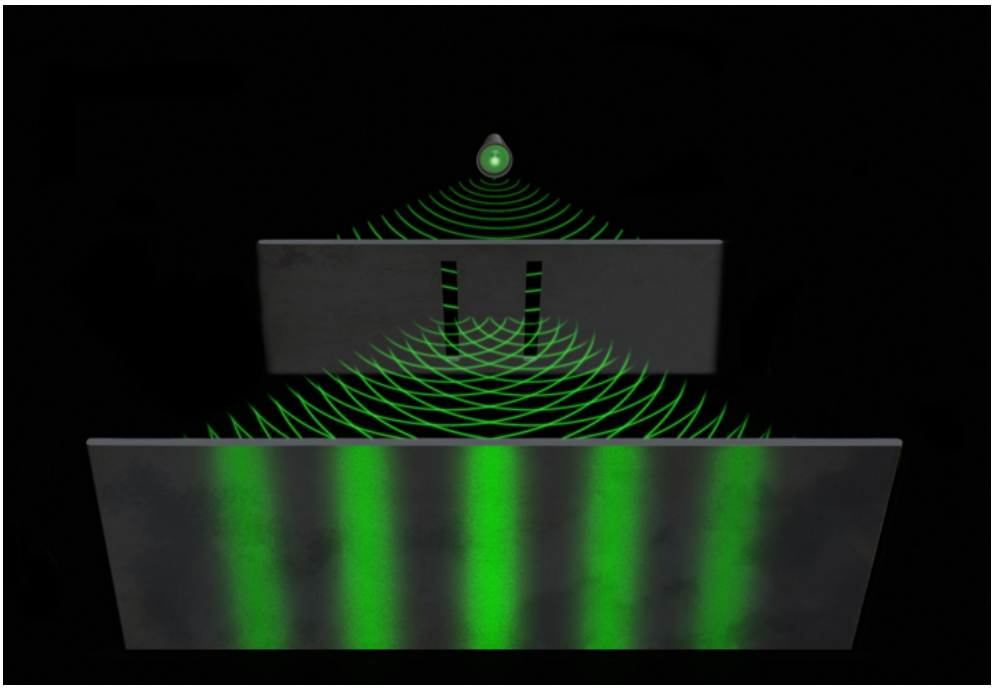
https://youtu.be/1-_IRbu1gAo

Experiments, on both the macro and micro levels demonstrate that randomness is not the principle determining motion in our universe of space-time, but rather it is waves and distributions of mathematical and orderly shape that are the influencers of particle motion, resulting, over time, in ordered, not chaotic patterns.

When and as a quantum particle, photon, electron, atom, or molecule moves through space it encounters the resistance of Faraday's space force (dark energy). This impact results in a wave of peaks and troughs in a region or volume of space not unlike the wake created by the passage of a ship through water.

Einstein and virtually the entire physics community accepted the findings from Eddington's observation of the solar eclipse in 1919—that light curves around, is piloted along its pathway, is conditioned by the gravity effect of a body of mass . . . in that case the Sun. We might have thought it would have occurred to the Solvay attendees that the same space-bending gravity effect could also occur, only in smaller degree, surrounding *any* particle, even an electron. But alas, this apparently did not occur to them, but it did to Louis de Broglie.

De Broglie came to his understanding mathematically and empirically. He saw in the double-slit experiment the most direct explanation: moving particles create a warping and waving of the properties of space around themselves, and the particles' trajectory is influenced deterministically by the shape of the waves so created. And these were called pilot waves.



Green light as one wave passes through two slits, and rearranges as two intersecting waves, resulting in more light reaching the center of the destination screen.

As you can see from this diagram, the band in the center is the brightest—the interference (intersection) pattern is such that the greatest confluence of light collects in the center. This occurs from the joining of the light waveforms formed after passing through the two slits. There is less energy and intersection toward the sides.

> 42:4.14 The quantity of energy taken in or given out when electronic or other positions are shifted is always a "quantum" or some multiple thereof, but the vibratory or wavelike behavior of such units of energy is wholly determined by the dimensions of the material structures concerned. Such wavelike energy ripples are 860 times the diameters of the ultimatons, electrons, atoms, or other units thus performing. The never-ending confusion attending the observation of the wave mechanics of quantum behavior is due to **the superimposition of energy waves: Two crests can combine to make a double-height crest, while a crest and a trough may combine, thus producing mutual cancellation.**

If this is starting to make some sense to you about right now, then I say, Congratulations, you're getting it! But then your next question may be, What has all the brouhaha been about? I can only say this historical science study has been, for me, as much about human nature as it has been about science. It has proven again to me that sometimes scientists can be as adamant as adherents to orthodox religions.

I must say that this study is not merely a textbook exercise. The principles involved here are pivotal and have much to do with the present and future of electronics, communications, warfare, energy production, transportation, ecology, biology, astronomy, philosophy, wealth, and ultimately sociology and human wellbeing.

David Bohm is a scientist we should learn more about.
Here is a list of his accomplishments, fields of research, discoveries, and associations:

Known for	Bohm-diffusion Bohm interpretation De Broglie–Bohm theory Hidden variable theory Bohm quantum potential Aharonov–Bohm effect Einstein–Podolsky–Rosen–Bohm paradox Holographic paradigm Holomovement Holonomic brain theory Bohm dialogue Bohm criterion Nonradiation condition Pilot wave Plasmon Implicate and explicate order

	Random phase approximation Quantum decoherence Quantum mind
Influences	Albert Einstein Jiddu Krishnamurti
Influenced	John Stewart Bell Peter Senge
Notable awards	1991 Elliott Cresson Medal 1990 Royal Society fellowship

A Summary of Pilot Wave theory vs. the Copenhagen Interpretation

Pilot wave theory proposes that quantum and other particles moving through space create waves in the gravitational fabric of space (warping of the properties of space) and that these particles are thereby carried along, piloted, in highly deterministic trajectories into predictable destinations and distributions along the lines of classical physics. A particle remains a particle and is moved along its pathway through space which itself has taken on a waveform. Thus, a moving particle displays its particle-like behavior by dutifully arriving intact to its destination, and the resultant warping of space is the associated phenomenon that provides a pattern (wave) able to condition and direct (pilot) the particle.

This theory requires that (a) particles remain particles, (b) space force must be able to take on a waveform as a result of its perturbation by the moving particle, and (c) there must be a nonmaterial force presence (such as the postulated *dark energy*) which is capable of perturbation by way of providing a level of resistance to the motion of a particle.

Therefore, in the double-slit experiment, the wave entering each of the two open slits split into two waves which combine forces and create a predictable interference pattern able to carry each particle along deterministic, not probabilistic, trajectories with expected results showing up as dark and light bands on the destination surface. This theory is referred to as realistic, causally-based, and deterministic, and conforms to classical physics of motion.

The Copenhagen interpretation says that the subject in question is neither just a particle or a wave, but both simultaneously; that prior conditions, such as original trajectory are not causal, that is they do not participate in the trajectory of the particle-wave; that trajectories are not determinable, but rather that each emitted particle begins with all possibilities of trajectory and probabilistically may take any of the infinite pathways. The interpretation allows that waveforms, of course, exist, but that the waveform collapses when an observer looks at it— that question, from this view, is moot, however, because the interpretation does not allow that waves have or had any ability to influence the motion of a particle in the first place.

Therefore, in the double-slit experiment, according to the Copenhagen interpretation, the characteristic pattern of bands appearing on the destination surface are the result of particles "choosing" some pathways over others from an infinite set of possibilities. But, if it was not looked at, then some other result could obtain. This interpretation is referred to as probabilistic, and does not purport to rely upon the classical physics of motion.

Philosophies of Louis de Broglie and David Bohm

Louis de Broglie, the man, seems from these quotes to be a sincere and gentle thinker:

Science Quotes by Prince Louis-Victor de Broglie

> After long reflection in solitude and meditation, I suddenly had the idea, during the year 1923, that the discovery made by Einstein in 1905 should be generalized by extending it to all material particles and notably to electrons.
>
> Preface to his re-edited 1924 Ph.D. Thesis, *Recherches sur la théorie des quanta* (1963), 4. In Steve Adams, *Frontiers* (2000), 13.

> Many scientists have tried to make determinism and complementarity the basis of conclusions that seem to me weak and dangerous; for instance, they have used Heisenberg's uncertainty principle to bolster up human free will, though his principle, which applies exclusively to the behavior of electrons and is the direct result of microphysical measurement techniques, has nothing to do with human freedom of choice. It is far safer and wiser that the physicist remain on the solid ground of theoretical physics itself and eschew the shifting sands of philosophic extrapolations.
>
> *New Perspectives in Physics* (1962), viii.

> Science itself, no matter whether it is the search for truth or merely the need to gain control over the external world, to alleviate suffering, or to prolong life, is ultimately a matter of feeling, or rather, of desire-the desire to know or the desire to realize.
>
> *New Perspectives in Physics* (1962), 196.

> There is no reason why the history and philosophy of science should not be taught in such a way as to bring home to all pupils the grandeur of science and the scope of its discoveries.
>
> *New Perspectives in Physics* (1962), 195.

> Thus with every advance in our scientific knowledge new elements come up, often forcing us to recast our entire picture of physical reality. No doubt, theorists would much prefer to perfect and amend their theories rather than be obliged to scrap them continually. But this obligation is the condition and price of all scientific progress.
>
> *New Perspectives in Physics* (1962), 31.

> Vulnerable, like all men, to the temptations of arrogance, of which intellectual pride is the worst, he [the scientist] must nevertheless remain sincere and modest, if only because his studies constantly bring home to him that, compared with the gigantic aims of science, his own contribution, no matter how important, is only a drop in the ocean of truth.
>
> **— Prince Louis-Victor de Broglie**
> *New Perspectives in Physics* (1962), 215.

Much more is available about the life of **David Bohm** because of his numerous books and taped interviews which are freely available to view. Bohm also appears as a gentle person, intelligent, and one who does not tip-toe around philosophy but rather plunges fully into the interrelationships of mind, spirit, and physics in a holographic universe.

Here are some quotes from Bohm:

> "The ability to perceive or think differently is more important than the knowledge gained."
> **— David Bohm**

> "There is a difficulty with only one person changing. People call that person a great saint or a great mystic or a great leader, and they say, 'Well, he's different from me - I could never do it.' What's wrong with most people is that they have this block - they feel they could never make a difference, and therefore, they never face the possibility, because it is too disturbing, too frightening."
> **— David Bohm**

> "Space is not empty. It is full, a plenum as opposed to a vacuum, and is the ground for the existence of everything, including ourselves. The universe is not separate from this cosmic sea of energy."
> **— David Bohm**

> "Indeed, the attempt to live according to the notion that the fragments are really separate is, in essence, what has led to the growing series of extremely urgent crises that is confronting us today."
> **— David Bohm**

> "Ultimately, all moments are really one, therefore now is an eternity."
> **— David Bohm**

> "For both the rich and the poor, life is dominated by an ever growing current of problems, most of which seem to have no real and lasting solution. Clearly we have not touched the

deeper causes of our troubles. It is the main point of this book that the ultimate source of all these problems is in thought itself, the very thing of which our civilization is most proud, and therefore the one thing that is "hidden" because of our failure seriously to engage with its actual working in our own individual lives and in the life of society."
— David Bohm

"Some might say: 'Fragmentation of cities, religions, political systems, conflict in the form of wars, general violence, fratricide, etc., are the reality. Wholeness is only an ideal, toward which we should perhaps strive.' But this is not what is being said here. Rather, what should be said is that wholeness is what is real, and that fragmentation is the response of this whole to man's action, guided by illusory perception, which is shaped by fragmentary thought."
— David Bohm, ***Wholeness and the Implicate Order***

"The question is how our own meanings are related to those of the universe as a whole. We could say that our action toward the whole universe is a result of what it means to be us."
— David Bohm, ***The Essential David Bohm***

"Many individuals going beyond the 'normal' limits of fragmentation are classified as paranoid, schizoid, psychotic, etc."
— David Bohm, ***Wholeness and the Implicate Order***

"But the ability to learn in this way is a principle common to the whole of humanity. Thus it is well known that a child learns to walk, to talk, and to know his way around the world just by trying something out and seeing what happens, then modifying what he does (or thinks) in accordance with what has actually happened. In this way, he spends his first few years in a wonderfully creative way, discovering all sorts of things that are new to him, and this leads people to look back on childhood as a kind of lost paradise. As the child grows older, however, learning takes on a narrower meaning. In school, he learns by repetition to accumulate knowledge, so as to please the teacher and pass examinations. At work, he learns in a similar way, so as to make a living, or for some other utilitarian purpose, and not mainly for the love of the action of learning itself. So his ability to see something new and original gradually dies away. And without it there is evidently no ground from which anything can grow."
— David Bohm, ***On Creativity***

"[T]here is a universal flux that cannot be defined explicitly but which can be known only implicitly, as indicated by the explicitly definable forms and shapes, some stable and some unstable, that can be abstracted from the universal flux. In this flow, mind and matter are not separate substances. Rather, they are different aspects of our whole and unbroken movement."
— David Bohm, ***Wholeness and the Implicate Order***

"Thus, in scientific research, a great deal of our thinking is in terms of theories. The word 'theory' derives from the Greek 'theoria', which has the same root as 'theatre', in a word meaning 'to view' or 'to make a spectacle'. Thus, it might be said that a theory is primarily a form of insight, i.e. a way of looking at the world, and not a form of knowledge of how the world is."
— David Bohm, ***Wholeness and the Implicate Order***

"All effort to bring order into disorder is disorder."
— David Bohm, ***The Limits of Thought: Discussions between J. Krishnamurti and David Bohm***

"So the relationship of each moment in the whole to all the others is implied by its total content: the way in which it 'holds' all the others enfolded within it."
— David Bohm, ***Wholeness and the Implicate Order***

"Indeed, the attempt to live according to the notion that the fragments are really separate is, in essence, what has led to the growing series of extremely urgent crises that is confronting us today. Thus, as is now well known, this way of life has brought about pollution, destruction of the balance of nature, over-population, world-wide economic and political disorder, and the creation of an overall environment that is neither physically nor mentally healthy for most of the people who have to live in it."
— David Bohm, ***Wholeness and the Implicate Order***

"If each one of us can give full attention to what is actually 'blocking' communication while he is also attending properly to the content of what is communicated, then we may be able to create something new between us, something of very great significance for bringing to an end the at present insoluble problems of the individual and of society."
— David Bohm

"it has always been both necessary and proper for man, in his thinking, to divide things up, and to separate them, so as to reduce his problems to manageable proportions; for evidently, if in our practical technical work we tried to deal with the whole of reality all at once, we would be swamped. So, in certain ways, the creation of special subjects of study and the division of labor was an important step forward."
— David Bohm, ***Wholeness and the Implicate Order***

"What prevents theoretical insights from going beyond existing limitations and changing to meet new facts is just the belief that theories give true knowledge of reality (which implies, of

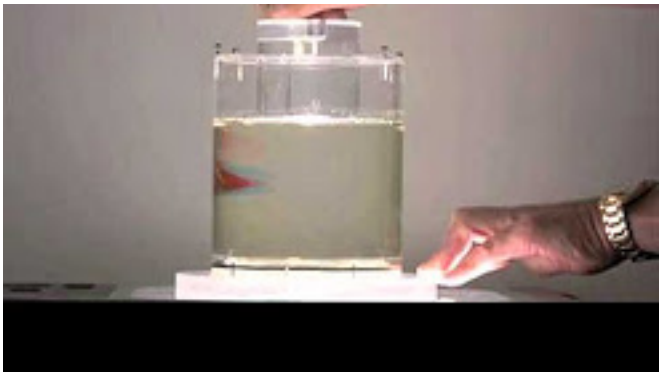
course, that they need never change)."
— David Bohm, ***Wholeness and the Implicate Order***

"it is widely felt that if there is to be any general world view it should be taken as the 'received' and 'final' notion concerning the nature of reality. But my attitude has, from the beginning, been that our notions concerning cosmology and the general nature of reality are in a continuous process of development, and that one may have to start with ideas that are merely some sort of improvement over what has thus far been available, and to go on from there to ideas that are better."
— David Bohm, ***Wholeness and the Implicate Order***

"Pribram has given evidence backing up his suggestion that memories are generally recorded all over the brain in such a way that information concerning a given object or quality is not stored in a particular cell or localized part of the brain but rather that all the information is enfolded over the whole."
— David Bohm, ***Wholeness and the Implicate Order***

"The notion that all these fragments are separately existent is evidently an illusion, and this illusion cannot do other than lead to endless conflict and confusion."
— David Bohm, ***Wholeness and the Implicate Order***

An interesting experiment involving drops of ink in a circulating viscous liquid, that David Bohm refers to, gives a visual representation conceptually of Bohm's implicate (folded) order, and the explicate (unfolded) order. The demonstration can be seen here:



Mixed fluid returns to its original state upon rewinding the paddle
https://youtu.be/UpJ-kGII074

The purpose of this essay has been to describe Louis de Broglies' and David Bohm's notable contributions to our understanding of the motions of particles through space--their pilot wave theory. That has been done, and I hope satisfactorily. My intention is also to relate the potential world implications of what I consider a most important improvement and development in quantum physics research.

For a concise and understandable description of pilot wave theory, I recommend you view this excellent PBS Digital Studio video below entitled "Pilot Wave Theory and Quantum Realism." It will help you immensely to visualize that which has been discussed so far in this essay.

https://youtu.be/RlXdsyctD50

I have intended to make this information intelligible and useful to a wide audience—the reader who needs an introduction, the interested science reader who enjoys a historical and human interest story, and as well the scientist who seeks clarification on the genesis and development of pilot wave theory.

But there is more. Remember that it was debated whether de Broglie successfully rebutted the argument brought up by Pauli at the 1927 Solvay Conference, and that this important issue was later resolved with David Bohm's contribution. That pivotal question is dealt with in a following closer look, a part two for those who desire more information and scientific discussion. First we examine more history on the two men, and then will segue into an exploration of non-locality and gravity as the universal information matrix.

More History on the Two Men

Louis de Broglie

It must be noted that David Bohm rediscovered de Broglie's idea of the pilot wave without knowledge that Broglie had proposed this idea decades earlier. If this seems at first surprising, remember that de Broglie abruptly dropped his proposal after it was dismissed by colleagues in 1927. The theory never got off the ground, and for a time was forgotten or ignored by the science community.

De Broglie did not take up again discussions of his pilot wave theory until the later decades of his life. He was a prince from a wealthy royal family, born into privilege. He had won a Nobel Prize for another discovery, possibly the most important discovery to launch quantum physics, regarding wave phenomena. He was held in the highest esteem in France's, and even the world's scientific communities. Perhaps he felt that jumping into that battle again during those years would provide neither him or anyone else any benefit.

Physicists must always represent their views in mathematical terms, and both de Broglie and Bohm were accomplished mathematicians. De Broglie was a Solvay Conference member, won the Nobel Prize for Physics in 1929 after the wave-like behavior of matter was experimentally discovered in 1927. He is notably credited with the discovery that wave phenomena always attend particle motion, and this was foundational to the beginnings of quantum theory. His 1925 pilot wave model was later used by Erwin Schrodinger in his formulation of wave mechanics. De Broglie served as the perpetual Secretary of the French Academy of Sciences, and he became the first high-level scientist to call for a multi-national laboratory, a proposal that led to the European Organization for Nuclear Research (CERN).

David Bohm

David Bohm held a Royal Society fellowship (1990). Here are some details of his trials and tribulations:

> After the war (WWII), Bohm became an assistant professor at Princeton University, where he worked closely with Albert Einstein. In May 1949, the House Un-American Activities Committee called upon Bohm to testify because of his previous ties to suspected Communists. Bohm invoked his Fifth amendment right to refuse to testify, and refused to give evidence against his colleagues.

In 1950 Bohm was arrested for refusing to answer HUAC's questions. He was acquitted in May 1951, but Princeton had already suspended him. After the acquittal, Bohm's colleagues sought to have him reinstated at Princeton, and Einstein reportedly wanted him to serve as his assistant, but Princeton President Harold W. Dodds[9] decided not to renew Bohm's contract. His request to go to Manchester received Einstein's support but was unsuccessful.[10] Bohm then left for Brazil to assume a professorship of physics at the University of São Paulo at Jayme Tiomno's invitation, and on Einstein's and Oppenheimer's recommendation.

In 1957 Bohm relocated to the United Kingdom as a research fellow at the University of Bristol. In 1959 Bohm and Aharonov discovered the Aharonov–Bohm effect, showing how a magnetic field could affect a region of space in which the field had been shielded, although its vector potential did not vanish there. This showed for the first time that the magnetic vector potential, hitherto a mathematical convenience, could have real physical (quantum) effects. In 1961 Bohm was made Professor of Theoretical Physics at the University of London's Birkbeck College, becoming emeritus in 1987. His collected papers are stored there.[24] [Wikipedia: David Bohm]

Non-locality and Gravity

These two reality principles, non-locality and gravity are considered together because it isn't feasible to consider them apart; they are interdependent and co-existent. They are not forces but they are space conditions. Non-locality refers to consequences and conditions that exist broadly in the universe, or narrowly in respect to related particles. If the behavior of a single particle is considered, then that is a local phenomenon. If two electrons interrelate within an atom, or if they are a million miles apart then that is a non-local relationship. Gravity is a consequence of the bending of space surrounding an object of mass that conditions or changes the trajectory of a traveling particle; the space immediately surrounding a moving particle is likewise pertrubed.

For a pilot wave system to work and be consistent with accepted concepts of wave formation, from the Schrodinger equation forward, it was recognized that so-called **hidden variables** must be in play. This term means to convey the concept that each particle's location is communicated to all other conceivably associable particles. A serious objection was raised to de Broglie's concept of a pilot wave by John von Neumann who published a paper in 1932 claiming to prove that all such hidden variable theories were impossible. The problem with von Neumann's assertion was that it dealt only with local hidden variables, not non-local. This flaw was discovered by mathematician Grete Hermann three years later in 1935 but this went unnoticed in the physics community for over fifty years!

Here is a partial list of the harrowing sequence of events, spanning over sixty years, that led us up to today:

Pauli presents in 1925 his exclusion principle showing how half-spin fermions may be entangled
De Broglie presents his pilot wave theory at the 1927 Solvay Conference
Pauli makes his objections, and de Broglie drops his proposal
Niels Bohr and Werner von Heisenburg scuttle pilot wave, and promote their interpretation
John van Neumann incorrectly claims that all hidden variable theories are impossible
Grete Hermann finds the flaw in von Neumann's conclusions, but her work goes unnoticed

David Bohm rediscovers pilot wave theory on his own, unaware of de Broglie's work
John Bell continues Grete Hermann's work, opens the door for non-local hidden variables
Quantum entanglement at a distance (non-locality) is demonstrated empirically
Copenhagen interpretation now has a serious contender in pilot wave theory

David Bohm did not prefer the term "hidden variables" as he did not conclude that they were hidden, but rather "most directly manifested in an observation" and preferred the term "implicate order" meaning that which organizes a particle within a field.

Depiction of "hidden variables" relating particle information in the implicate order

The decisive issue that would break the logjam regarding the viability of the pilot wave theory had to be whether particles could be "aware" of other particles instantaneously at a distance. For that to be the case then gravity in space must act as such a universal information matrix.

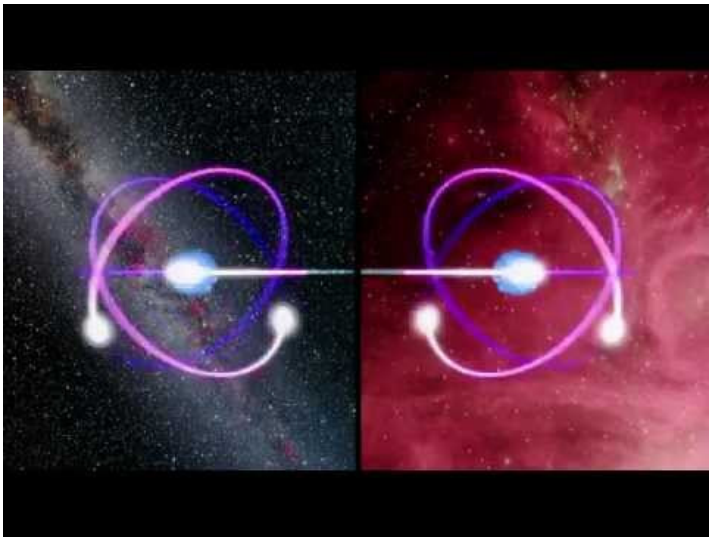
Part Two

Gravity in Space as Universal Information Matrix

Action at a Distance.

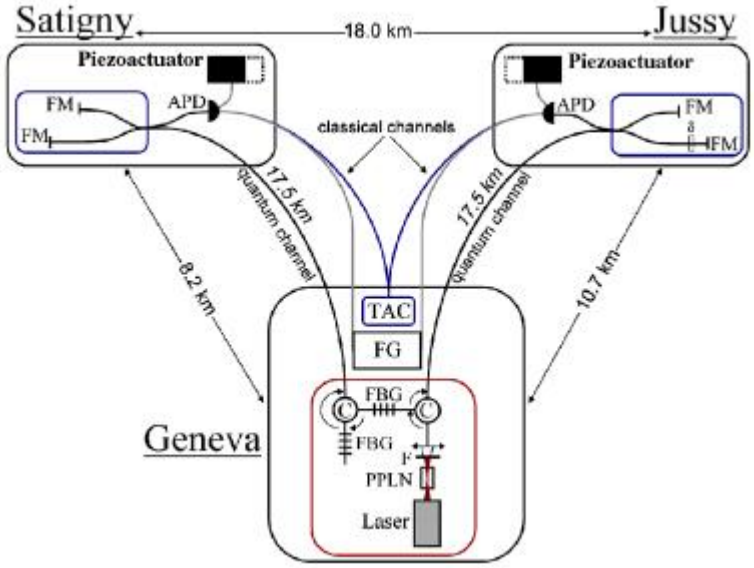
The most arresting physics phenomenon regarding instantaneous action or communication at a distance has to do with Wolfgang Pauli's Exclusion Principle of 1925. Pauli stated that sub-atomic particles, half-spin fermions, in certain pairs, even when separated by the most considerable distances, can each instantly "know" what the other is doing.

It is as if, in the words of the science writer Lawrence Joseph, you had two identical billiard balls, one in Ohio and the other in Fiji, and the instant you sent one spinning the other would spin in a contrary direction at precisely the same moment.



Entangled particles

Remarkably, seventy-two years later, in 1997, Pauli's hypothesis was demonstrated at the University of Geneva. Photons were sent miles apart in two opposite directions and it was observed that interfering with one provoked an instantaneous (faster than the speed of light) response in the other.



Two entangled photon singlets are sent from Geneva by fiber optic cables, one to Satigny, and the other to Jussy

The experiment was first designed and performed by French physicist Alain Aspect in Orsay's Institut d'Optique in 1982. A single photon was split into separate "twin" photon singlets with interrelated properties. The particles traveled away from each other in opposite directions through specially designed fiber-optic chambers. At the end of these pathways, the twin particles were forced to choose between two possible routes. Curiously, the particles made precisely the same choices and traveled the same directional paths.

Nicolas Gisin successfully repeated the experiment in 1997 over longer distances. His results were announced to 3,400 journalists, scientists, educators, and engineers in more than 40 countries.

Because of its oddities, many physicists, including Einstein disliked these quantum theories, or at least certain aspects of them. The idea of action at a distance—that one particle could instantly influence another trillions of miles away—was a stark violation of the special theory of relativity, that decreed that nothing could outrace the speed of light.

No Time Delay with Gravity

Once again we're presented with the roadblock of physics' limited understanding of the properties of space and space force. There is no time delay in the action of gravity. Gravity is not a "thing" or a "force" but is rather a "consequence" of the warping of space/force around moving bodies of mass.

Newton a long time ago claimed that a rock moved on the moon would cause a gravity effect on the earth. Scientists still hold to this, but generally say that it would take 1.28 seconds (the time required for light to travel from the moon to earth) for this effect to occur. However, this mistaken idea has never been demonstrated. Gravity is a phenomenon that has never been observed to require a period of time for it to either "travel" or to manifest. Its action is always and everywhere instantaneous. Any effort to ascribe the physical properties of matter and energy to gravity in space is fruitless, as space is not material.

Theoretical physicists are, of course, exploring how particles achieve such feats of action at a distance. Mostly, scientists have dealt with the problem, according to the physicist Yakir Aharanov, "by not thinking about it."

Dark Energy—the Force Blanket of Space.

So, let us think about it. Space is not empty, as David Bohm corroborates: "Space is not empty. It is full, a plenum as opposed to a vacuum, and is the ground for the existence of everything, including ourselves. The universe is not separate from this cosmic sea of energy." Every space body, whether a planet, a sun, an atom, or an electron plunges through a vast ocean of Faraday's primordial force energy, the ancestor of all energy and matter—including the energetic radiation from extragalactic cosmic rays whose unknown origin astrophysicists still seek.

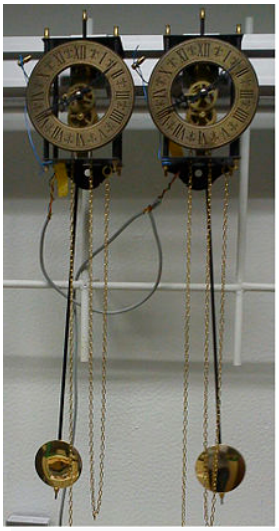
Every motion of the largest or the smallest space body, or spinning particle exerts a gravity effect that permeates in some degree instantaneously through space. The gravity effect diminishes according to the inverse of the square of the distance, and it can be nullified by antigravity, but it cannot be delayed. There is no time requirement for the propagation of the gravity wave effect created by the space perturbations from even a lowly electron or smallest subatomic particle. Everything in motion creates a gravity effect, and everything is always in motion.

When a stream of photons, released for example upon electronic collision, moves through space, they encounter the ubiquitous ocean of primordial force, and the space force around them is thereby perturbed. For this reason the photon exhibits both particle and wave phenomena. The excited "waveform" of the "particles" of light is hundreds of times larger in scope than the photons themselves, and their gravity ripples extend throughout the universe. This perturbation of space force oscillates outward in all directions and touches, to some degree, unless eventually nullified by antigravity, bodies throughout the universe, as surely as a wave from a pebble dropped in a pond touches every floating leaf in its path. But with space, and in nonmaterial space, the effect is instantaneous—such measurements as the speed of light are of no account, as gravity is not an electromagnetic phenomenon.

Let us consider again the Geneva experiment of distant photons and their instantaneous reactions. Picture the two positions of the photons in a fraction of a microsecond from when and where they were sent, when they were only an inch apart from one another. They were gravitationally affecting one another at that moment. A simple triangulation could deduce the other's location. But what other properties could be known? An electron's rate of axial revolution is beyond human comprehension. (De Broglie early speculated that electrons had a clock speed mechanism.) This incredible rate could be viewed as a sample rate, much as we view sample rates for audio and video—higher sampling rates for greater resolution. That yields data and information. An electron's orbital revolution is not simply like a planet orbiting the sun, but is rather like a cloud within its orbital shell. The resultant stupendously rich force actions and reactions within space continuously communicate gravity information. In the Geneva experiment the two photon singlets were paired from the start, coming from a common source from which they were split.

Entrainment

It has been proposed by information scientists that in the internet of everything, conceivably every object within a discreet set could be tagged, identified, and correlated. This idea is not beyond comprehension in the realms of data processing. It is also not beyond conception that streams of photons from a common source could exhibit phase locking or mode locking, a phenomenon well known wherein two similar objects become entrained in motion, such as two pendulum clocks on a mantle, due to small amounts of energy passed from one to the other through the air and through their shared mantle upon which they rest. If you set in motion the pendulums of two clocks of very similar manufacture on a mantle and return a short time later, you will observe their two pendulums to be swinging together in the same directions and close to the same tempo. That is entrainment.



Experimental setup of Huygens synchronization of two pendulum clocks

https://youtu.be/hRWzhQbgBew

The instant effect of gravity in space provides for a quantum entrainment, or entanglement of particles. If you can accept that the modification or warping of space force by subatomic particles can occur instantaneously within an atom (space exists within the atom), and also around these two described photons an inch apart, then could you also conceive, as in the Geneva experiment, that such gravity ripples through space blanket of force, Bohm's "cosmic sea of energy," could also occur fourteen miles apart? Or a trillion miles apart?

Extremely faint radio signals can be successfully received on earth from probes as far as Pluto and beyond. How? Because the exact transmitting frequency is known. Likewise, two diverging photons from a common light source, having been split by a semi-transparent mirror or a specially prepared crystal, as in the Geneva experiment, are already entrained, and thereby entangled, from their start. They are harmonically related to each other from their point of origin. Their energy signature relationship is uniquely paired—they "know" each other.

Space as a Vast Information Matrix

What this demonstrates is that nonmaterial space and its content of space force is an information matrix, performing vast data exchange instantly, by gravity, which effect is not constrained by the laws of thermodynamics that govern matter and energy. Gravity is simply not a matter-energy or electromagnetic phenomenon; rather gravity is a resultant effect of mass and movement upon the fabric of space.

Two distant electrons or photons have qualities of spin (axial revolution), orbital shape and frequency, trajectory, and in effect have an energy signature unique, an identity, if you will. In the case of two photons entangled "from birth," they share their "unique" signature; and it is safe to say that no other photon in the universe shares that exact signature.

By extrapolation we can conceive, and within limits have observed, that every mass body does indeed gravitationally affect every other mass body in the universe, calibrated by mass and distance. Antigravity and repulsion effects are just as well part of the equation. Thus space is an enormous matrix of information that communicates and organizes, and conditions motion for every galaxy, star, planet, atom, and ultimate particle universally. Every single motion instantly and automatically becomes a part of and updates the vast database of universe motion, holographically.

Evolution of the Willing and the Unwilling

Timeline of "action at a distance" and related research:

1. 1925 Pauli's exclusion principle, postulating instant action at a distance
2. 1947 Einstein was unwilling to accept Pauli's concept, calling it "spooky action at a distance"
3. 1997 Nicolas Gisin sends two entangled photons fourteen miles apart
4. 2015 Harry Cliff discusses "Is this the end of physics?" in a TEDTalk

At the heart of this debate are two seemingly opposed things: The laws of physics that prohibit speeds faster than light, and observation of entangled particles that are observed to act instantly, that is faster than light.

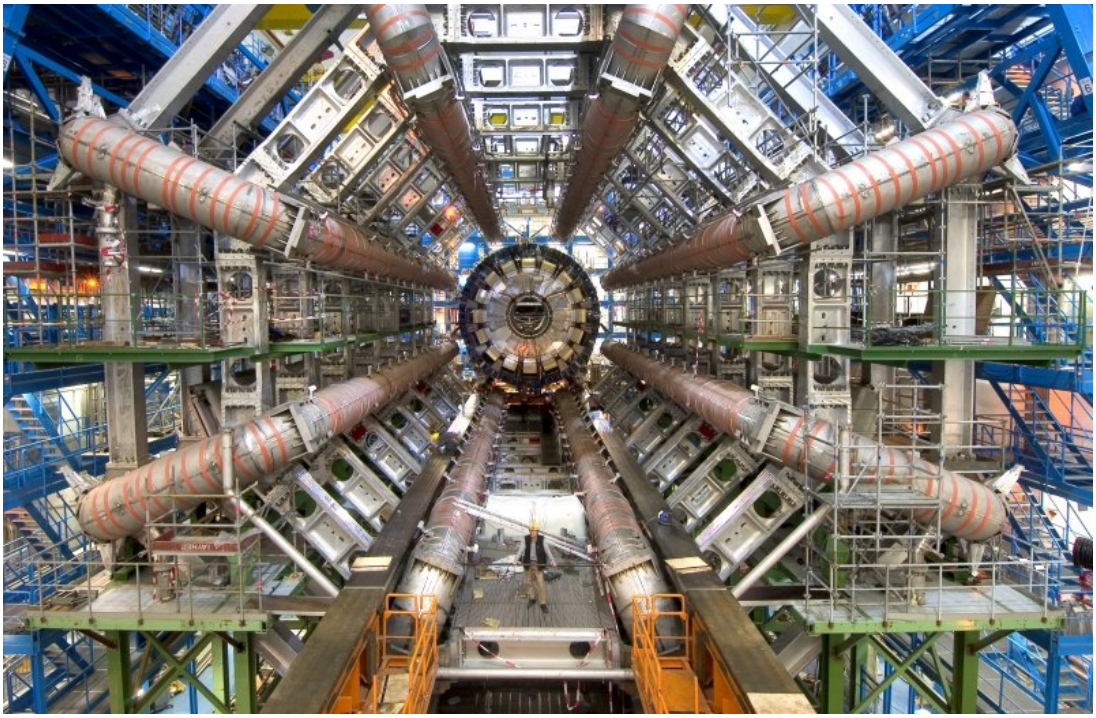
On one hand we have those who insist that communication cannot occur faster than light, and on the other, those who continue research in quantum entanglement that has demonstrated instantaneous action at a distance.

Einstein was the one who defined the speed of light limit, so it is understandable that he had problems with Pauli's principle. Einstein, at minimum, felt that our understanding of quantum physics was not adequate at that time to explain such a phenomenon, and called it "*spukhafte Fernwirkung.*" And yet without his discoveries and theories about gravity the efforts of de Broglie and Bohm, who both worked closely with Einstein, could not have developed.

Oddly, the Swiss scientist, Nicolas Gisin, appears prominently in both camps. He is the one who most clearly demonstrated Pauli's principle by actually sending two photon singlets, split from a single photon, along fiber optic cables in Switzerland. Interestingly, his experiment was conducted not far from the Patent office where Einstein worked as a young man. Gisin's experiment was made possible by new techniques involving a specially prepared crystal capable of splitting a photon (and other like techniques); an existing fiber optic cable network; and new equipment capable of reliably detecting a single photon, one such device on each end. Also needed are clocks, now available, which can measure occurrences in billionths of a second, and therefore can demonstrate if an action occurs faster than the speed of light. Yet Gisin insists, most emphatically, that his experiment does not demonstrate instant action at a distance, or communication or anything at all happening faster than the speed of light—why? because to say that would contradict Einstein. This he explains in his book, *Quantum Chance: Nonlocality, Teleportation and Other Quantum Marvels,* which I have read carefully in its entirety. And yet, he also tells us that he does not know how the quantum entanglement he has demonstrated does, or could take place! His adherence to this orthodoxy, however, has not kept him from forming a company that is providing business

services, including advanced cryptography, using the principles he has managed to empirically demonstrate.

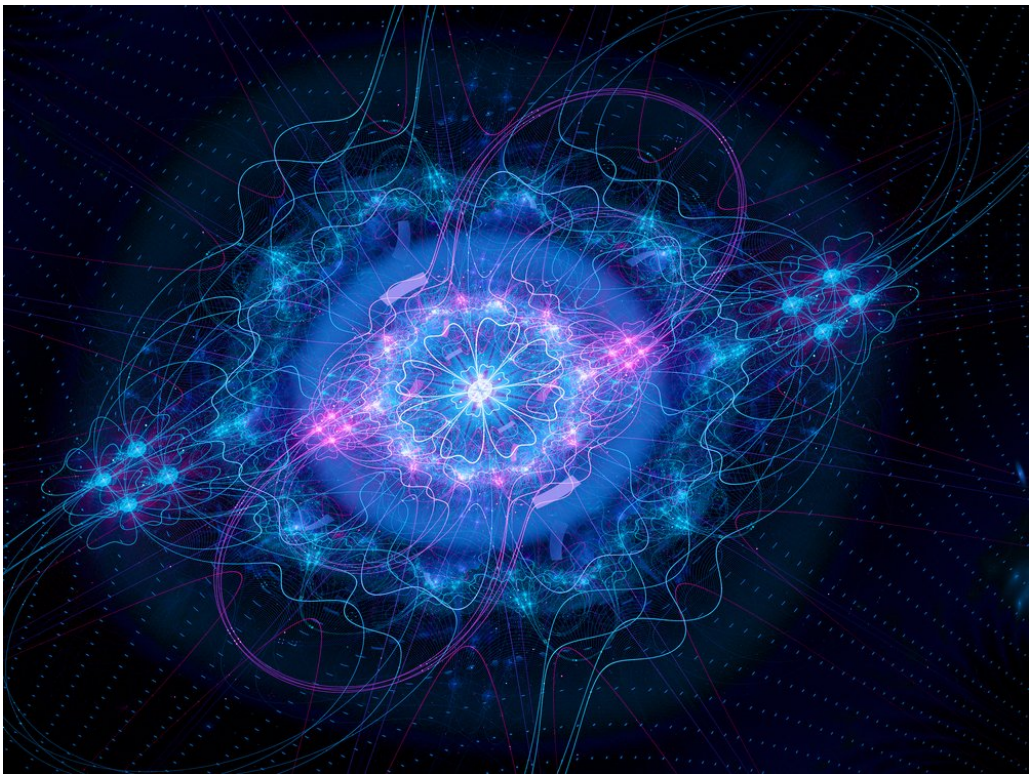
Physicists universally accept that matter and energy do not travel faster than light, and I accept that as well. However, as CERN physicist Harry Cliff so honestly expresses, we are reaching the limit of what classical physics research can tell us, and that limit is precisely met at the standard table of elementary particles, and its newest discovered member, the Higgs Boson. It is unknown by CERN scientists whether they will able to discover with their Large Hadron Collider even smaller components making up the known elementary particles, but they are keen to find out.



Hadron Collider at CERN lab in Switzerland (see man standing in foreground)

Let us consider thoughtfully at this point, that if a particle is smaller than any of the known elementary particles—a theorized component of such particles—could it not follow that such a component particle would not necessarily demonstrate electrical characteristics? If such a particle is pre-electronic, then we must perforce not look for its qualities existent as part of the electromagnetic spectrum. Physicists are now interested to know what makes up the quark, the muon, the electron, and all the known elementary particles. And, the Higgs field, that Cliff describes as permeating all space (and the energy source accreting into the elementary particles) may be viewed as pre-energy, or the postulated dark energy, or as Bohm's "cosmic sea of energy" or as Lemaitre's quanta. We could therefore conceive of the sought-for smaller particles as a candidate for the "ultimaton," and the Higgs field perhaps as Faraday's everywhere primordial force-charge of space.

I find it quizzical that Cliff considers these newest findings as "dangerous" and "frightening" as if somehow the stability of the universe was imperiled, whereas it is only the current state of physics research which is apparently in an emergency. Actually, by informing us that physics research may be reaching a limit of sorts, we may in turn learn much more about the greatest stability of all—gravity in space and the pre-energy field pervading all space. Harry Cliff's TEDTalk may be linked to here: https://youtu.be/gWPFJgLAzu4



Higgs Boson and field, artist's conception

So, to Nicolas Gisin, I say, and agree, that there is no need, necessity, suggestion, or requirement that either energy or matter exceed the speed of light. But, that the effect of gravity arising from the warping of space *is simply not an energy-matter (mass) phenomenon*, but is rather *a space and space-force phenomenon*, and is therefore not governed by the thermodynamic or electromagnetic laws of matter and energy.

Gravity is understood, since the times of Einstein and Lemaitre, as a result that conditions the motions of bodies in space through paths of lessened or increased resistance. There will be no understanding or solution of the Geneva experiment without reckoning with the attributes of nonmaterial space and the primordial force blanket of all space (the hypothesized dark energy, or Higgs field), and how these space realities create the conditions for gravity effects that do not require time for their propagation.

As renowned physicist Georges Lemaitre stated, there is no need to resort to "metaphysical" explanations for the deepest universe realities, but that these are "natural" occurrences. Now that science has begun to conceptualize the reality of so-called dark energy pervading all space, we can

contemplate that space is the realm wherein units of this space *force* (actually pre-energy, or "pure" energy—nonmaterial force) can bend, warp, move, ripple, and wave in response to every movement of material bodies through it. Universe motion is not like a child's ball on the playroom floor that rolls and stops—even that child's ball has set force in motion, felt throughout the reaches of space.

Implications Regarding Gravity

If you ask an astronomer if gravity is what keeps all the whirling bodies of space in their dependable orbits he or she will unhesitatingly answer, "Yes." However if you ask what exactly gravity is, the response may not be so quick. The scientist will describe the warping of space as the condition that creates a gravitational response along lesser or greater paths of resistance between bodies, but the explanation may not go much farther.

Gravity is the universal information matrix in space; that is, gravity is the absolutely ultimate, reliable, and consistent phenomenon in the universe of time and space. It's not just a good idea, "It's the law."

Computer scientists and communication technologists seeking ever faster communication speeds are dissatisfied with the speed of light. They could do more with faster speeds. All the galaxies move in their dependable synchrony because every part is in gravitational interrelationship or "communication" with every other part. It is clear, as with the Geneva experiment, that if gravity detection was utilized as the mode of communication, then the current electromagnetical spectrum speed barrier would be effectively broken. If the observation of a distant galaxy were made gravitationally then the limits of conventional telescopy would be of no account—the universe would become instantaneously observable.

The future of space exploration and communication, both terrestrial and celestial, likely lies in gravimetrics, and this field of study is growing by leaps and bounds.

While scientists quibble over whether distant particles (such as photons) can instantly communicate information (I am aware of the debate over the use of the terms *information* and *communication* in these regards) the Chinese have gone ahead with utilizing entangled photons to do just that with a satellite launched in August, 2016.

> "It [the satellite] is nicknamed 'Micius,' after a fifth century BC Chinese philosopher and scientist who has been credited as the first one in human history conducting optical experiments.
>
> In its two-year mission, QUESS is designed to establish 'hack-proof' quantum communications by transmitting uncrackable keys from space to the ground, and provide insights into the strangest phenomenon in quantum physics -- quantum entanglement.

> Quantum communication boasts ultra-high security as a quantum photon can neither be separated nor duplicated. It is hence impossible to wiretap, intercept or crack the information transmitted through it.
>
> With the help of the new satellite, scientists will be able to test quantum key distribution between the satellite and ground stations, and conduct secure quantum communications between Beijing and Xinjiang's Urumqi.
>
> QUESS, as planned, will also beam entangled photons to two earth stations, 1,200 kilometers apart, in a move to test quantum entanglement over a greater distance, as well as test quantum teleportation between a ground station in Ali, Tibet, and itself.
>
> 'The newly-launched satellite marks a transition in China's role -- from a follower in classic information technology (IT) development to one of the leaders guiding future IT achievements,' said Pan Jianwei, chief scientist of QUESS project with the Chinese Academy of Sciences (CAS).
>
> The scientists now are expecting quantum communications to fundamentally change human development in the next two or three decades, as there are enormous prospects for applying the new generation of communication . . ."
>
> [http://www.chinadaily.com.cn/china/2016-08/16/content_26484910.htm]

Gravity is not stopped by objects of mass, and such objects have space within them, right down to the space around muons, quarks, gluons, and all elementary particles. Atomic matter is filled mostly with space, and space is the "medium" of gravity results. We can well understand how a neutrino can pass untouched through many feet of metal plating. And, if in the future we wanted to gravimetrically view the Andromeda galaxy, but on that day Jupiter or the Sun was in the way, perhaps that would not be a problem for future techniques. Gravity has not been observed to be stopped by the imposition of material mass; but rather that objects of mass curve the space around their center of gravity and thereby create conditions for the attraction and repulsion of other aggregations of mass or energy as they traverse through their proximal space paths of increased or lessened resistance.

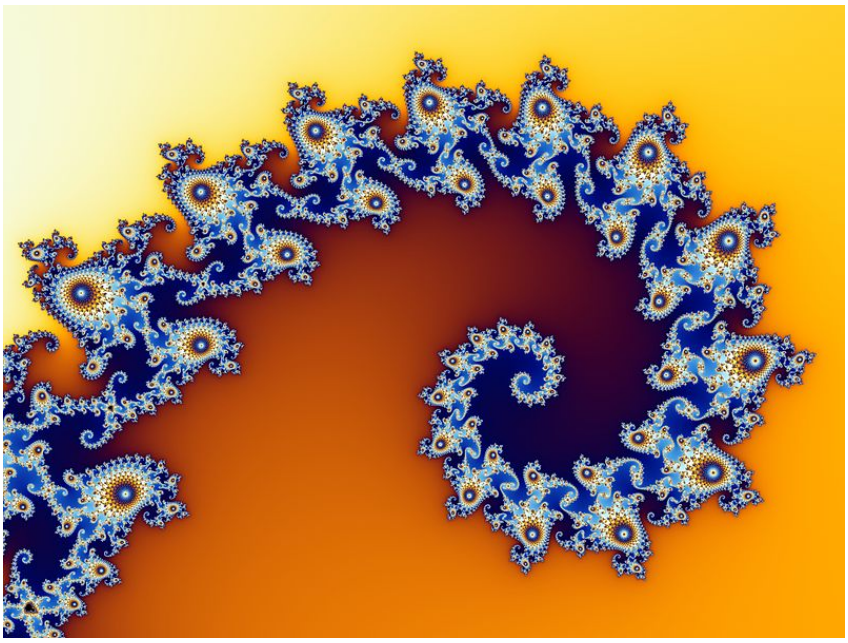
Light or space dust or meteorites may bend with the curved space around a planet, and pass it by; or on the other hand, if their combined trajectory, electrical characteristics, mass, and speed are propitious they can be captured by the planet, either into an orbit, or by collision. A small enough particle such as the neutrino may simply pass through a planet or other space body.

The Holographic Universe

The term holographic refers to the concept that the part is contained within the whole, and the whole is contained in the part. The animal and human brains work in this way—information

is spread out through the brain as a whole, and not contained simply in local areas as previously conceived.

This principle can be visually represented in the mathematical Mandelbrot sets, and in nature, such as in the broccoli romanesco.



Mandelbrot set

Broccoli Romanesco, a delicious vegetable

In the mathematical equations for the Mandelbrot sets, shapes are multiplied in such a way that ever increasing zooming inward of produced images continuously repeat the same image. In the

broccoli romanesco, likewise, the smallest parts, when looked at with a magnifying glass, reveal the same shape as the whole.

In a holographic universe context the meaning conveys that the universe is a whole, and that the parts are connected with each other gravitationally. This is David Bohm's implicate (enfolded) order that displays outward as the observable explicate (unfolded) order, always moving toward balance, settling.

For those scientists who still dislike the idea that entangled particles can "communicate" information instantaneously (but are yet unable to explain how this entanglement is effected) I reply, "What would be a more acceptable term? Shall we utilize 'implicate order', 'entrainment', '*spukhafte Fernwirkung*', or 'hidden variables'?"

Or, shall we examine the results. Gravity does the big things: dark gravity bodies are able to hold entire starry systems in effective leash. Gravity does the little things: electrons, protons, and neutrons are kept in proper relationship to each other within an atom. It does the medium-sized things: Pluto, Venus, and Earth are kept in dependable orbital relationship to each other and to the Sun. Gravity does the surprising thing: it keeps two distant entangled photons in relationship to one another.

And gravity also does the amazing thing: it keeps particles continuously aware of any other particles in the finite universe that its ripples manage to reach. That is a holographic order, or relationship. Without that reality in play, there will be no satisfactory explanation of the double-slit experiment in particular, and no useful explanation in general of the overall mechanics of particle movement and reciprocal wave formation.

This holographic idea, if taken to its infinitesimal degree, suggests an ultimate particle (which CERN scientists seek), but goes further to that particle's ancestor of space force (Faraday's concept), and even further yet inward to its (Bohm's) pregeometry nucleus of *absolutum* origin of unique and homogenous space potency (Lemaitre's primeval quantum).

Taken to the maximum degree outward, the large scale universe can be viewed properly as a whole of synergistic, gravitationally interrelated reciprocal parts.

In my analysis, Louis de Broglie, David Bohm, and John Bell got it right: space is real; space is not empty but is pervaded by space-force throughout; particles and their movements are realistic and determinable; energy is real; gravity is real; and order is real.

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ABOUT THE AUTHOR

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His writings center on the harmonization of philosophy and science.

Hobbies include camping and hiking.