DOI: https://doi.org/10.24297/jac.v17i.8865

The Periodic Table needs negative orbitals in order to eliminate quantum weirdness: a new quantum chemistry mathematics

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Abstract: A consensus among quantum experts is that the quantum world is not properly understood. It is a mistake to think we can cure quantum weirdness by tinkering with superficial aspects of quantum mechanics (QM). We propose that nature uses ($-\psi$) as its wave function, whereas QM uses ($+\psi$). We propose therefore that the Periodical Table should be changed to negative orbitals ($-\psi$). Surprisingly, this change makes almost no difference to chemistry on a practical level. The Born rule takes the absolute square of an amplitude to obtain a probability to test in chemistry lab $P=|-\psi|^2=|+\psi|^2$. We propose a new math based on ($-\psi$) that is the mirror image of quantum mathematics. We call it the Theory of Elementary Waves (TEW). The negative sign is not an electrical charge. It has nothing to do with Coulomb's law. Valence electrons are unchanged. Ions, covalent bonds, dipoles, metals, hydrogen bonding and the hydrogen 21 cm line are unchanged. The octet rule and rules for drawing dot structures of molecules do not change. Amino acids, sugars and DNA do not change their handedness. We cite abundant experimental evidence showing that TEW is correct and QM is wrong.

Subject Classification: Library of Congress id.worldcat.org/fast/1085090/ quantum chemistry math models

Keywords: Theory of Elementary Waves (TEW), hydrogen orbitals, zero energy waves, quantum weirdness.

I. Introduction

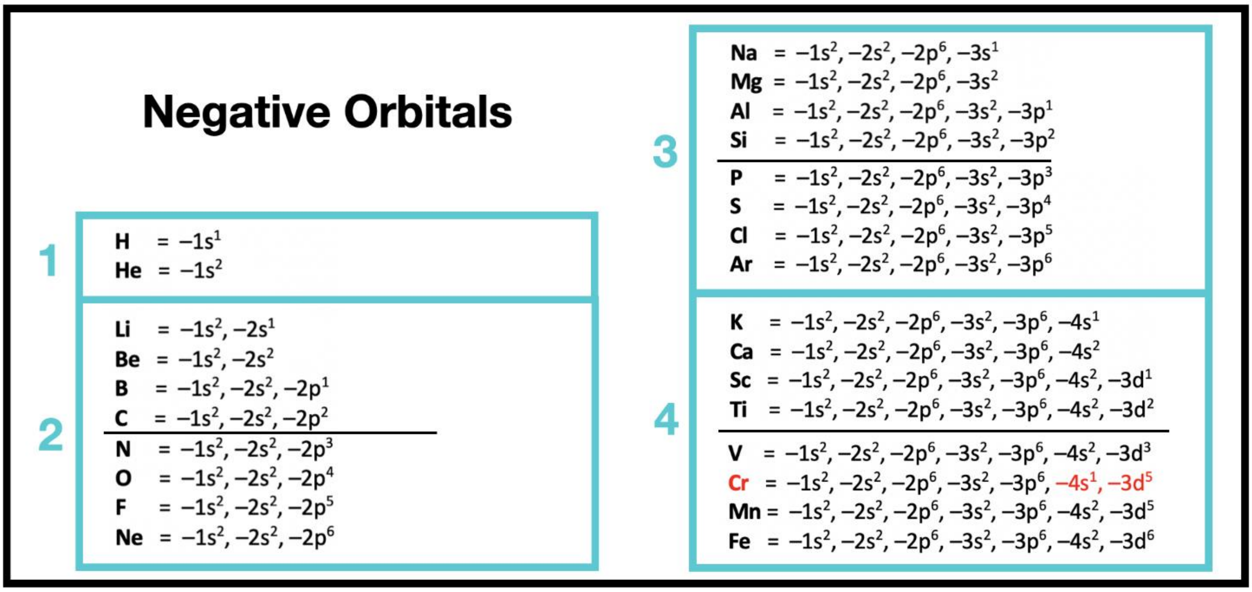


Fig. 1 Negative Orbitals up through iron, including the chromium exception.

It is incorrectly said that quantum mathematics has been proved empirically. For example when Schrödinger created his equation in 1925, it immediately replaced Bohr's planetary model of the atom, and gave us the structure behind the Periodic Table. (1,3,39) This spectacular success proves that the ***probability*** predictions of QM are accurate. But that does NOT mean that quantum wave equations are trustworthy. If the wave equations were 100% backwards, if they gave us a negative photograph of reality ($-\psi$), they would produce the same probability predictions, because of the Born rule ($P = |+\psi|^2 = |-\psi|^2$). Therefore the success of chemical sciences does not prove that quantum equations are correct. The Born rule is hiding the fact that ***nature is a mirror image of what QM pictures it to be.*** (4-27)

A new theory, the Theory of Elementary Waves (TEW) takes quantum weirdness seriously as an indicator that a fundamental mistake was made in the early 1920's in the starting assumptions of QM. If we correct that mistake, we end up with negative orbitals, and also a clear picture of the quantum world, free of weirdness, and still gives us the same science and technology. The voodoo and dark magic would vanish from QM.

Quantum math is based on a wave function (ψ). TEW is based on the negative of that wave function ($-\psi$). This results in a picture of the quantum world which is astonishingly similar to the world of everyday experience in the following ways: the Schrödinger cat paradox disappears, there is no "measurement problem", time only goes forwards, wave function collapse occurs ***before*** we observe something and, surprisingly, there is no wave particle duality. The one peculiar thing about the new picture of the quantum world is that particles follow zero energy waves backwards.

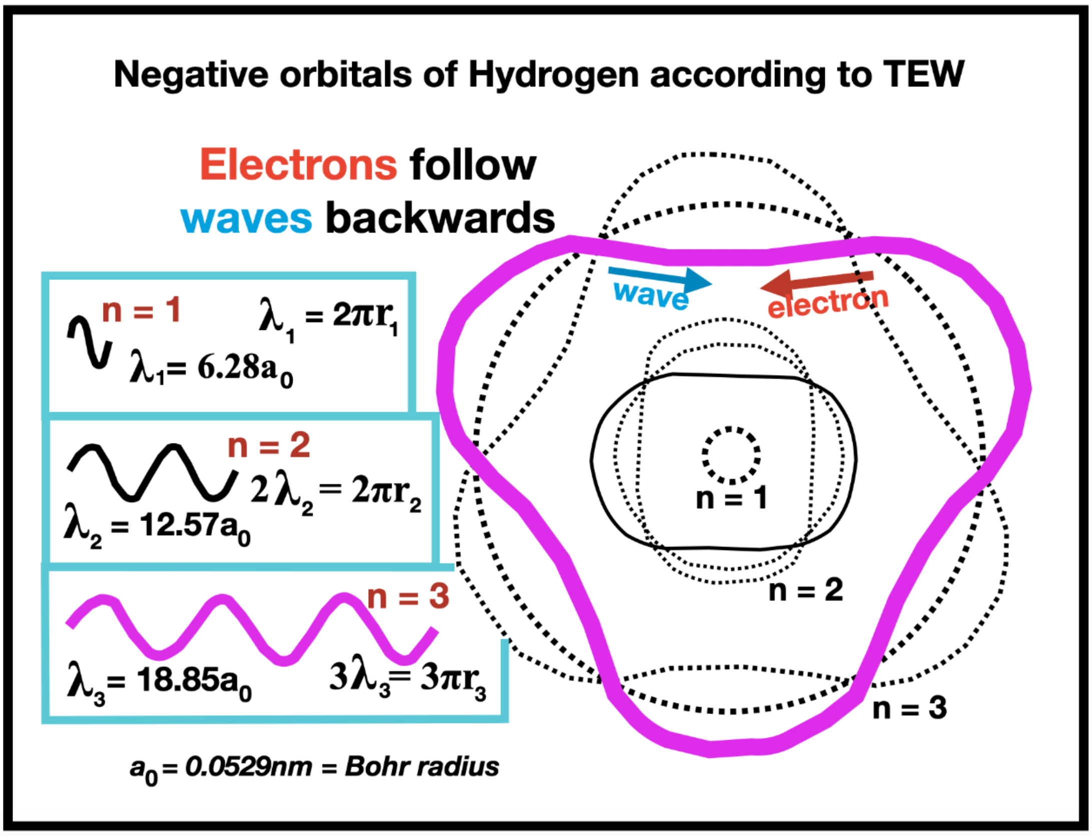


Fig. 2. Elementary Wave Negative Orbitals for the first three shells of Hydrogen. The elementary waves follow these orbitals. The electrons simply follow the waves, moving in the opposite direction as the waves.

Rather than seeking to "interpret" QM, we are negating quantum math. This article presents an alternative mathematics for quantum phenomena, not an alternative "interpretation" of the customary mathematics. If quantum math is correct then this article is wrong, and vice versa. There is substantial empirical data that nature is better described by TEW than by QM. In the "Discussion" section we will present some of the empirical data, which comes from non-chemical branches of science.

1.1 The weirdness tax

American author Mark Twain said, "Truth is sometimes stranger than fiction." He explained why, "because fiction must be plausible." Truth is sometimes neither plausible nor believable. The idea that particles follow waves backwards is preposterous. Yet, it is verifiable, as you will see in the "Discussion" section.

What people complain about with TEW is that it is weird to say that particles follow zero energy waves backwards. We agree, it is weird. TEW pays its **weirdness tax** up front. QM avoids paying its weirdness tax. It makes sensible starting assumptions, then goes on in a logical way to describe the quantum world as if it were weird, which it is not.

It is a mistake to think you can avoid paying your taxes. Three things in life are unavoidable: weirdness, taxes and death.

If you don't pay your weirdness tax up front, then the taxing authority clobbers you with a penalty forever. QM is forever burdened with a misperception of the quantum world as if it were weird. QM does not get away with its tax evasion.

Richard Feynman said, "If you think you understand quantum mechanics, you don't." This article, as unbelievable as it is, will explain the quantum world in a way that fixes that problem. We "explain" the quantum world in the sense that we define the insanity in a concise way. Historically that is one way science has solved insoluble problems. First define the problem in a concise way. Then define that concise idea as a "law of nature." We say that a law of nature is that $(-\psi)$ is the correct wave function. We invite you to look at nature through that lens. You be the judge.

TEW contradicts wave particle duality. Many readers believe wave particle duality is obvious if you look at a double slit experiment. ***That is wrong.*** There are at least two reasons that is wrong. First, Einstein completely demolished that interpretation of the double slit experiment, as we will show. Second, Richard Feynman said that no one can explain the double slit experiment. Feynman said that because he never read this article. This article can and will do what Feynman said no one could do. (9,14)

This proposal about negative amplitudes $|-\psi|$ is so radically different than the assumptions of science today that several things are required of us. First we need to show how our mathematics differs from standard QM chemistry math. Second we must present some of the abundant evidence that supports TEW and contradicts QM. Third, we need to explain how and why mainstream science got so far off course. We will do all that, but it is a complicated argument that cannot be stated in 25 words.

1.2 History

It helps to know this author's history of wrestling with this question. The author is not a professional chemist, although in his medical training he learned inorganic, organic, biochemistry, neurochemistry, pharmacology and genetics. The author has worked for half a century as a physician (M.D.) taking care of sick people. In November 2020 he retired.

The author's cousin, Lewis E. Little earned a PhD in physics in 1974 and was troubled by quantum weirdness, since it was a signal that an error had been made in the starting assumptions of QM. Little spent 30 years ***alone*** as a theoretical physicist seeking to revise QM assumptions, and eventually discovered the "law of nature" mentioned above: that quantum particles follow waves backwards. He published TEW in a physics journal (*Physics Essays*) and presented it at the Jet Propulsion labs. But overall the physics community was not the least bit interested. Some physicists said, "This is not science." (41-44)

In 2020 this author began to present TEW to professional physicists, thinking incorrectly that if TEW were presented well, the physics community would be persuaded. This author joined the American Physical Society (APS) and presented TEW 18 times over the last decade. Doing so, he learned how physicists react to this theory. One audience asked, "Why haven't you received a Nobel Prize?" Another physicist said, "Don't worry about not being a professional physicist, Einstein worked in the Swiss Patent Office." Mostly there were blank stares, as if physics audiences didn't know how to think about such an unusual viewpoint. They had never heard anything like it. TEW did not fit into their paradigm of how Nature is organized.

Until 2011 TEW had no mathematics. It consisted of a simple metaphysical model: quantum particles following waves backwards. This author complained to Lewis Little that TEW needed a mathematics.

Little replied, "OK, it is ***your*** task to build it, since you have a degree in mathematics." The author's bachelor's degree from Brown University in 1965 was as a math major. But half a century had passed since then. His math brain had rusted from disuse. He had lost his mathematical self-confidence. In mathematics self-confidence and perseverance are central.

There was an urgent need for a TEW mathematics. No one else was willing to tackle the problem. So this author tackled it, as you will see. It is like someone asking, "Why did you climb K2, it is such a savage mountain." If this author had climbed K2, the answer would be, "Because it was there."

Over the past decade this author published 20 scholarly articles on TEW in peer reviewed journals of mathematics and physics: half in math, half in physics, none in chemistry before this article. In conjuring a new mathematics out of thin air, the author stumbled, struggled, and made mistakes. It was like climbing a cliff without ropes or climbing partners (free soloing). Slowly the author's ideas improved. In the process he unearthed and published a wealth of empirical evidence from mainstream physics journals showing that particles follow waves backwards, contrary to what QM teaches. (5-27)

The author's most coherent statement of TEW mathematics, prior to the article you are now reading, was in the August 2020 issue of the *Journal of Advances in Physics* (5), in which the mathematics of Richard Feynman's "Quantum Electrodynamics" (QED) was overhauled and re-built. (32-34) If "K" is Feynman's "kernel" (or "propagator"), we showed that nature uses a reverse kernel (or reverse propagator) "– K" because particles follow waves backwards. The propagator and reverse-propagator lead to the same empirical predictions, because of the Born rule:

$P = | +K |^2 = | -K |^2$

While writing that previous article, the author became aware that some of Feynman's QED could not be adapted to our purposes, because Feynman focuses on particles that travel from point "a" and end up at the same point, "a." That is what happens in atomic orbitals. That led the author to turn to the hydrogen atom as his next project. Until then TEW had limited itself to free particles.

1.3 Schrödinger wave for a free particle

To explain TEW we will start with the less sophisticated definition: "Particles follow waves backwards." The more sophisticated definition "Nature uses $(-\psi)$ instead of $(+\psi)$", will be presented in the Results section of this article.

Fig. 3 shows a free particle traveling from "a" to "b." The right side of **Fig. 3** shows that elementary waves start at detector "b", ***prior to*** the emission of the particle. The waves move centripetally toward a particle source "a", carrying probability amplitudes, but not energy. All probabilistic decisions are made at "a." For example if there are elementary rays converging on "a" from elsewhere, say points "c" and "d", then the particle makes a random decision about which of the incident waves to respond to, before it leaves the gun. The particle selects one and only one wave to follow backwards, and it makes that decision only once, at the particle source, "a." Once the particle leaves the gun it becomes a deterministic experiment. The particle then follows its wave backwards (from "a" to "b"), with a probability of one, to strike the detector "b" from which the elementary waves is emanating.

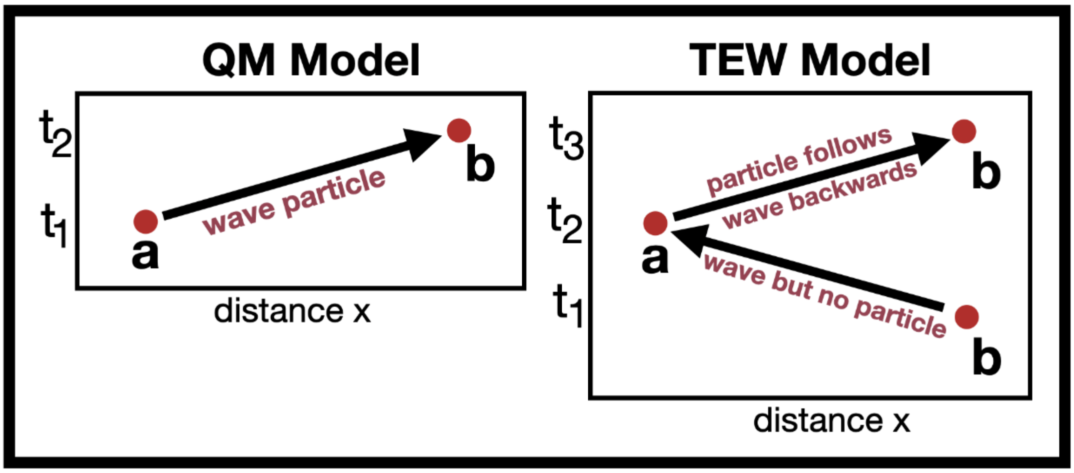


Fig. 3. Two interpretations of a free particle experiment in which a particle travels from "a" to "b". According to TEW (right) the Schrödinger wave travels from point "b" to "a" ***before the particle is emitted***. The Schrödinger wave is bi-directional. As the particle leaves point "a" wave function collapse occurs. The particle then follows its wave back to "b" with a probability of one.

For this article we define an elementary wave to be a bi-directional Schrödinger wave. Since most readers do not think of a Schrödinger wave as going in two directions simultaneously, we often call it an "elementary wave." The Schrödinger wave goes in two opposite directions as shown on the right of Fig. 3.

Like Schrödinger waves, Elementary Waves do not push or pull particles. They do no work. Like Schrödinger waves, Elementary waves carry amplitudes for energy, but they do not convey energy itself. A Schrödinger equation carries a Hamiltonian operator, but it does not carry the fiery turbulence of raw energy. It does not burn a hole in the paper. We don't need to confine Schrödinger waves inside an asbestos container lined with lead.

Like Schrödinger waves, elementary waves are figments of our mathematical imagination, not explosive forces of nature. The waves ***describe*** the probability amplitudes of ***how nature is likely to behave***, but do not coerce nature to behave that way. These waves are clouds of probability, but not turbulent winds that can rustle your hair or spin turbines.

1.4 Wave Function Collapse

A crucial difference between TEW and QM is the location and timing of wave function collapse. We start by defining the phrase. Originally, in the 1920's "wave function collapse" meant that all the eigenstates collapsed into one eigenstate. We will change the phrase to mean "a decisive event occurs." For example, you might at first flirt with and date many people. But then you marry one. ***That is wave function collapse.*** From then on you live with the consequences of that decision. The field of many dating options is no longer open. When a decisive event happens, the future is different afterwards.

The spread of the corona-19 virus in 2019-2021 was "wave function collapse." Things will never be the same again. If Schrödinger's cat suffered brain death from cyanide gas, that would be "wave function collapse." Something decisive happens when the cat dies, not when the corpse is observed.

In QM wave function collapse allegedly occurs at the measuring device. Bohr, Heisenberg and Pauli were strongly influenced by the Positivist School of Ernst Mach. Positivism stated that what you observe is the only thing you can know scientifically. "Reality" is limited to the meter readings. QM was originally built as a theory of meter readings. Einstein was an outcast in the QM community because he asserted that there was such a thing as physical reality. Ernst Mach denied the existence of physical reality. Mach said that the only thing that exists is what is observed. That is why QM calls operators "observables." (1,3)

In TEW wave function collapse is located at the particle gun, nanoseconds earlier than what QM believes to be true. TEW teaches that wave function collapse occurs when something decisive happens, not when the data are measured. QM is built on blips in the measuring devices used in experiments. TEW is devoted to understanding what happened earlier to cause those blips. Like Einstein, we take the controversial position that the physical world exists.

The Schrödinger cat paradox hinges on the question: When and where does wave function collapse occur? According to the Copenhagen interpretation it occurs when an observation is made. Humans "cause" the cat's superposition to collapse into a state of dead or alive by opening the lid of the box and looking. It is an absurd idea. Clearly the decisive event of the cat's brain death (or not) from cyanide occurred at an earlier time.

If you have the courage to declare it, what the Schrödinger's cat paradox says is: "QM makes a stupid assumption about wave function collapse."

But that is not what QM teaches. One teaching about Schrödinger's cat is that the quantum world is so weird that humans cannot understand it. "After all," some quantum experts say, "our assumptions about reality are based on our experience in the classical world. We cannot comprehend the contradictions intrinsic to the quantum world, because we have no experience of that world. Our common sense and intuition are based on our experience in the classical world, and is therefore irrelevant to understanding the quantum world."

We say that the quantum and classical worlds cannot contradict one another. The world of everyday experience is only a thin glaze over the quantum world. When we look at the classical world, what we see is the quantum world (scaled up by Avogadro's number). The window is transparent. If time never goes backwards in our experience, then time never goes backwards in the quantum world. Quantum weirdness means a mistake was made in the starting assumptions of QM. It is like saying, "Two plus two equals five."

Quantum weirdness is a thorn in the side of all quantum theory. It is worthwhile to ponder an alternative theory that gets rid of the weirdness. We propose that there is no quantum weirdness in nature. Our hypothesis is that TEW is a better representation of nature than is QM. Our math is better than QM math. The two mathematics do not agree.

2. Materials and Methods

This article will propose that the Schrödinger equation for Hydrogen is wrong. We will shortly propose an alternative. However the polar coordinates that are needed for a hydrogen atom are complicated. A better place to start explaining our new mathematical chemistry is with a one dimensional Schrödinger equation for a free particle, assuming rectilinear coordinates (x, t), as shown in **Fig. 3**.

In TEW particles follow Schrödinger waves backwards. To develop this idea in mathematical form we will start with a plain wave traveling to the left. The direction is important. The particle (which we can observe) travels to the right in **Fig. 3**. But ***before*** the particle is emitted, a wave travels to the left (**Fig. 3**).

Fig. 3 shows our model: Schrödinger waves start earlier than the emission of a particle. Waves start at point "b" (the detector) and move to point "a" before the particle is emitted. The wave offers the particle an opportunity to follow the wave backwards. If there are many competing waves, from points "c" and "d" for example, then each wave arrives at point "a" with a certain **amplitude** for the particle to randomly choose that Schrödinger wave to follow backwards. The particle chooses only one wave to follow from "a" to "b" and it makes that decision only once. Once the particle departs from "a" it follows its Schrödinger wave with a probability of one, and inevitably strikes point "b". By the time the particle leaves its source, wave function collapse has occurred. All probabilistic decisions are made by the particle before it is emitted. After the particle is emitted, the experiment is deterministic.

Because of the Heisenberg uncertainty principle, we cannot say specifically where the particle is, nor how fast it is moving. Chemists would prefer to know that information with less precision, because the more you know about position, the less you know about energy, and energy is what chemists care about.

$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

We will build our model starting with a simple plain wave moving from point "b" towards point "a" (**Fig. 3**). In Eq. (1) the variable "t" is always positive, because in TEW time only goes forwards, never backwards. The variables x and ω move in a negative direction (i.e. decrease in value). In order to symbolize the idea that this is a plain wave moving to the left, we give it the name "$-\psi$."

$$-\Psi = e^{i(kx-\omega t)} \qquad (1)$$

This is ***not a negative charge.*** The wave equations we are about to develop are not affected by Coulomb's law.

2.1 Deriving the Time Independent Schrödinger equation:

Our derivation of the Schrödinger equation is as follows. (31)

$$Re(-\Psi) = \cos(kx - \omega t) \quad (2)$$

$$k = p/\hbar \text{ where } p \text{ is momentum.} \quad (3)$$

$$Re(-\Psi) = \cos(\frac{px}{\hbar} - \omega t) \quad (4)$$

We define

$$E = \text{kinetic energy} + \text{potential energy}$$

$$E = \frac{1}{2}mv^2 + u = \frac{p^2}{2m} + u \quad (5)$$

Taking the derivative $\partial/\partial x$ of the wave function $-\Psi = e^{i(kx-\omega t)}$, we get:

$$\frac{\partial(-\Psi)}{\partial x} = -\frac{\partial(\Psi)}{\partial x} = ike^{i(kx-\omega t)} = ik(-\Psi) = -ik(\Psi) \quad (6)$$

$$\text{So,} \quad \frac{\partial(\Psi)}{\partial x} = ik(\Psi) \quad (7)$$

Then we differentiate again:

$$\frac{\partial^2(-\Psi)}{\partial x^2} = -\frac{\partial^2(\Psi)}{\partial x^2} = (ik)^2(-\Psi) = -k^2(-\Psi) = k^2\Psi = \left(\frac{p^2}{\hbar^2}\right)\Psi \quad (8)$$

$$\text{because} \quad k = \frac{p}{\hbar} \quad (9)$$

Therefore, when we multiply both sides by $\hbar^2$, we get: $$-\hbar^2\left(\frac{\partial^2(\Psi)}{\partial x^2}\right) = p^2\Psi \quad (10)$$

Multiplying both sides of $[E = (p^2/2m) + u]$, by $-\Psi$, we get:

$$-E\Psi = -\frac{p^2\Psi}{2m} - u\Psi \quad (11)$$

$$\text{or} \quad E\Psi = \frac{p^2\Psi}{2m} + u\Psi \quad (12)$$

and when we insert Eq. (10) to replace $p^2\Psi$, we get the **Time Independent Schrődinger Equation:**

$$E\Psi = -\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + u\Psi \ \mathbf{= TISE} \quad (13)$$

2.2 Deriving the Time Dependent Schrödinger equation:

The time dependent equation can be easily derived from the **TISE** by differentiating our wave equation by ∂t:

$$-\Psi = e^{i(kx-\omega t)} \quad \text{by } \partial/\partial t:$$

$$-\frac{\partial\Psi}{\partial t} = -i\,\omega\,\Psi \quad \text{or} \quad \frac{\partial\Psi}{\partial t} = +i\,\omega\,\Psi \quad (14)$$

We define $E = \hbar\omega$. Multiplying that by Ψ we get: (15)

$$E\Psi = \hbar\omega\Psi \quad (16)$$

$$-\frac{i}{\hbar}E\Psi = -i\omega\Psi = -\frac{\partial\Psi}{\partial t} \tag{17}$$

$$E\Psi = \frac{\hbar}{i}\frac{\partial\Psi}{\partial t} = -i\hbar\frac{\partial\Psi}{\partial t} \tag{18}$$

We can substitute that into the time dependent Schrődinger equation and get:

$$-i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + u\Psi \tag{19}$$

which is the **Time Dependent Schrődinger Equation, TDSE.**

We started with a plain wave traveling to the left, from point “b” to point “a” in **Fig. 3** and showed that it can take the form of a Schrödinger wave traveling from the detector to the particle source. When it arrives at the particle source (“a”), the particle is emitted and follows that same wave backwards to the detector. The Schrödinger wave is like a path that exists whether or not any particles are on the path.

Think of two strikes of lightning 100 milliseconds apart. The first one ionizes the air and thereby creates a pathway that becomes the channel for the next strike. That is like the relationship between the two paths in **Fig. 3**. The first path, from “b” to “a” is like the first strike of lightning, before the particle is emitted. The second path, from “a” to “b” is like the second strike through a channel created by the previous strike. In this analogy the two bolts of lightning travel in opposite directions. First a bolt of lightning goes from “b” to “a”, then 100 milliseconds later, a particle follows the same pathway from “a” to “b.”

This ends our discussion of the Schrödinger equation of a free particle in one dimensional TEW. We move now to polar coordinates.

2.3 The spherical harmonic functions of Laplace

We will now build some mathematical tools we will need later. Spherical harmonic functions were developed by Pierre-Simon Laplace in 1782, as solutions to the Laplacian (∇^2) being set to zero. Much of science is based on harmonic functions, meaning the Laplacian is set to zero ($\nabla^2 = 0$).

Systems described by harmonic functions are a central focus in science. For example, the temperature and air circulation in the room you are now sitting in would be described by a harmonic function. When the Laplacian equals zero, that means the divergence of the gradient is everywhere zero, which means the system is stable and continuous.

In polar coordinates the Laplacian is given by the following equation. (36)

Laplacian ∇^2

$$\overrightarrow{\nabla^2} \equiv \overbrace{\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2 sin^2\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right) + \frac{1}{r^2 sin^2\theta}\frac{\partial^2}{\partial\phi^2}} \tag{20}$$

Our Laplacian equation is:

$$\overrightarrow{\nabla^2}\ \Psi(r,\theta,\phi) = 0 \tag{21}$$

which can be solved by separation of variables: $\Psi(r,\theta,\phi) = R(r)\ P_l^m(\cos\theta)\ e^{\pm im\phi}$

where P_l^m is the associated Legendre polynomial.

For example, three Legendre polynomials would be:

$$P_0(\cos\theta) = 1$$

$$P_1(\cos\theta) = \cos\theta$$

$$P_2(\cos\theta) = \frac{1}{2}\left(3\cos^2\theta - 1\right)$$

We introduce spherical harmonics functions:

$$Y_l^m(\theta,\ \phi)$$

where *l*=0, 1, 2, 3,. . ., and m=-*l*, -*l*+1. . . *l*-1, *l*, defined by:

$$Y_l^m(\theta,\ \phi)\ =\ (-1)^m\sqrt{\frac{(2l+1)}{4\pi}\frac{(l-m)!}{l+m)!}}\ \ P_l^m(\cos\theta)\ e^{im\theta} \tag{22}$$

The phase factor $(-1)^m$ has been chosen so that the spherical harmonics are normalized to one. The spherical harmonic functions (Eq. 22) are orthonormal and complete.

$$-r^2\ \overrightarrow{\nabla^2}\ Y_l^m(\theta,\phi)=l(l+1)\ Y_l^m(\theta,\phi).$$

Here are the spherical harmonic functions for *l = 0, 1, 2.*

$$Y_0^0(\theta,\phi)\ =\ \sqrt{\frac{1}{4\pi}} \tag{23}$$

$$Y_1^0(\theta,\phi)\ =\ \sqrt{\frac{3}{4\pi}}\ cos\theta \tag{24}$$

$$Y_1^{\pm1}(\theta,\phi)\ =\mp\sqrt{\frac{3}{8\pi}}\ sin\theta\ e^{\pm\ i\phi} \tag{25}$$

$$Y_2^0(\theta,\phi)\ =\sqrt{\frac{5}{16\pi}}\ (3\cos^2\theta-1) \tag{26}$$

$$Y_2^{\pm1}(\theta,\phi)\ =\mp\sqrt{\frac{15}{8\pi}}\ \sin\theta\ \ \cos\theta\ e^{\pm\ i\phi} \tag{27}$$

$$Y_2^{\pm2}(\theta,\phi)\ =\sqrt{\frac{15}{32\pi}}\ \sin^2\theta\ \ e^{\pm\ 2\ i\phi} \tag{28}$$

You will see those equations again. The one circled in blue will be a recurrent theme.

Pierre-Simon Laplace developed this mathematics in France more than two centuries ago. How long ago was that? It was five years before Antoine Lavoisier first named hydrogen and recognized that oxygen was involved in combustion. It was during the rule of Jassa Singh Ahluwalia of the Sikh Confederacy, and before the United States Constitution was written. It never occurred to Laplace that he was defining the geometrical framework upon which the entire Periodic Table would eventually be built. Neither he nor Lavoisier ever imagined anything like the Periodic Table.

3. Results

We will now tackle the hydrogen atom, which requires polar coordinates. We start by developing the orthodox QM explanation of the hydrogen Schrödinger equation. Then we will modify that equation so as to present the negative orbitals of the TEW model. (40)

3.1 The Schrödinger model of hydrogen

We will assume the proton is the center of mass. We will ignore magnetic forces and intrinsic spin.

The Schrödinger equation written in spherical coordinates is:

$$\hat{H}(r,\theta,\phi)\Psi(r,\theta,\phi) = E\Psi(r,\theta,\phi) \tag{29}$$

For the hydrogen atom the Schrödinger equation also contains a Coulomb potential energy term, where r is the distance between the electron and the center of mass (which we have assumed to be located at the proton). (40)

$$\text{Coulomb potential energy:} \quad \hat{V}(r) = -\frac{e^2}{4\pi\epsilon_0 r}$$

The time independent Schrödinger equation around a central potential is:

$$\left\{-\frac{\hbar^2}{2\mu r^2}\overbrace{\left[\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right)+\frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right)+\frac{1}{\sin^2\theta}\frac{\partial^2}{\partial\phi^2}\right]}^{\text{Laplacian } \nabla^2}-\overbrace{\frac{e^2}{4\pi\epsilon_0 r}}^{\text{Coulomb potential energy}}\right\}\Psi(r,\theta,\phi)=E\Psi(r,\theta,\phi) \tag{30}$$

We can separate variables by using a product of a radial operator and a spherical harmonic function $Y_l^m(\theta,\phi)$.

$$\Psi(r,\theta,\phi) = R(r)Y_l^m(\theta,\phi) \tag{31}$$

The radial function *R*(r) contains information about how far the electron is from the nucleus. The assumption is made that if the electron were at an infinite distance from the proton, it would have an energy of zero. As the electron gets closer, its energy plunges down the energy well. It is easiest to understand if we look at **Fig. 4**.

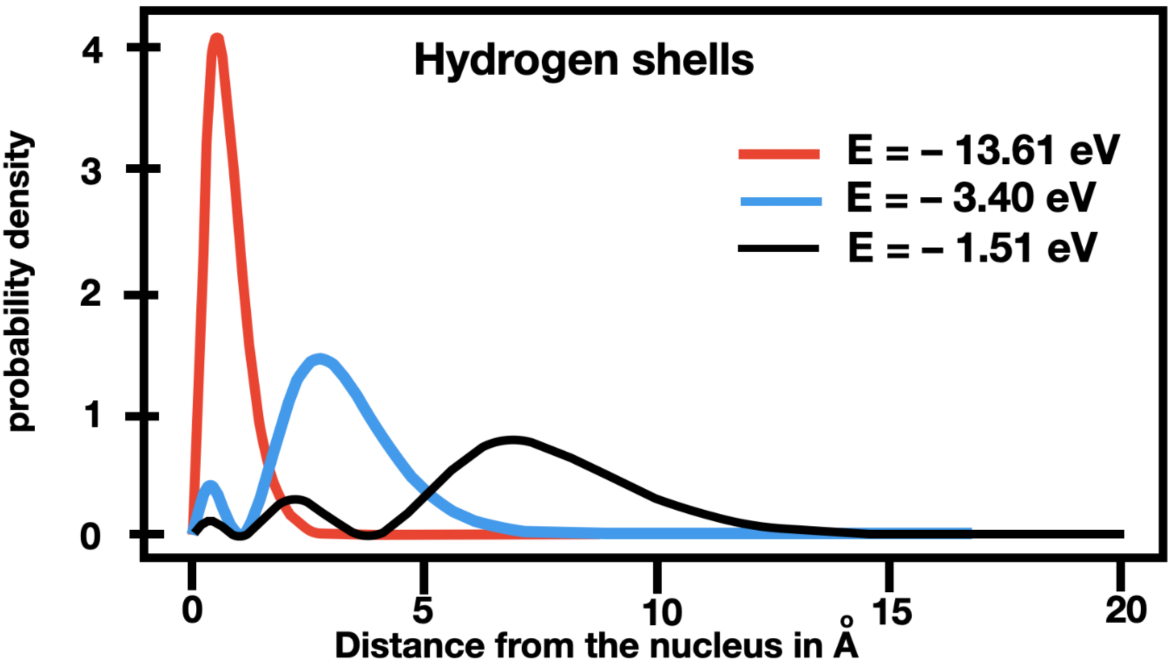


Fig. 4. Radial probability distribution or the first three shells of hydrogen of the radial function **R(r).**

The spherical harmonic function $Y_l^m(\theta,\phi)$ contains information about the electron's polar coordinates.

The following table presents the functions for the first three orbitals as solution of the Schrödinger equation in a spherical potential well:

$$\begin{pmatrix} l & m_l & +Y_l^m(\theta,\phi) \\ == & == & ================= \\ 0 & 0 & +\sqrt{\frac{1}{4\pi}} \\ 1 & 0 & +\left(\sqrt{\frac{3}{4\pi}}\right) cos\theta \\ 1 & \pm 1 & \mp\left(\sqrt{\frac{3}{8\pi}}\right) sin\theta\, e^{\pm i\phi} \\ 2 & 0 & +\left(\sqrt{\frac{5}{16\pi}}\right)\left(3cos^2\theta - 1\right) \\ 2 & \pm 1 & \pm\left(\frac{15}{8\pi}\right)\left(sin\theta\, cos\theta\, e^{\pm i\phi}\right) \\ 2 & \pm 2 & \mp\left(\frac{15}{32\pi}\right)\left(sin^2\theta\, e^{\mp 2i\phi}\right) \end{pmatrix}$$

watch this function change below

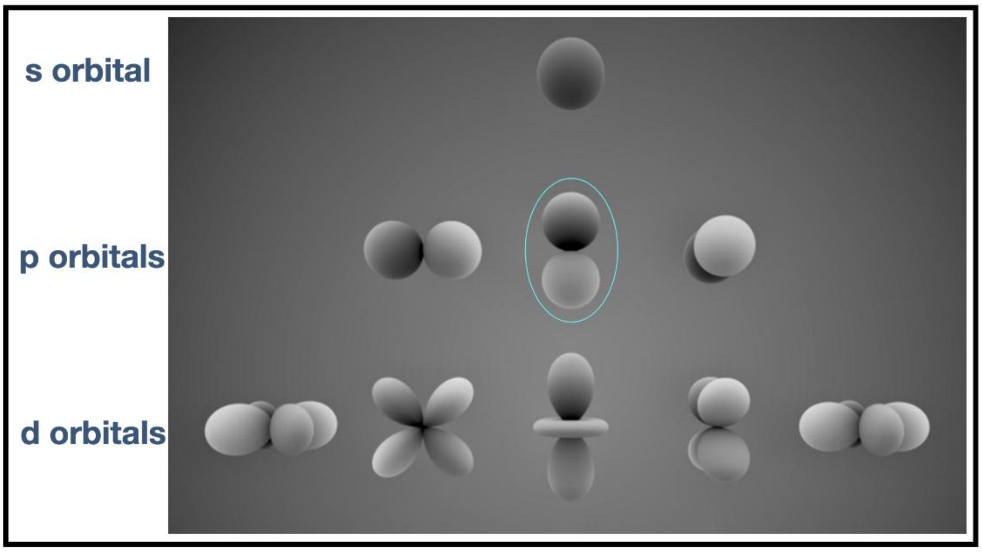


Fig. 5. Spherical harmonic functions $Y_l^m(\theta,\phi)$ for the first three orbitals as solution of the Schrödinger equation in a spherical potential well. These orbitals are orthogonal to one another and complete.

This skeleton of orbitals is the structure behind the Periodic Table, as everyone knows. (48)

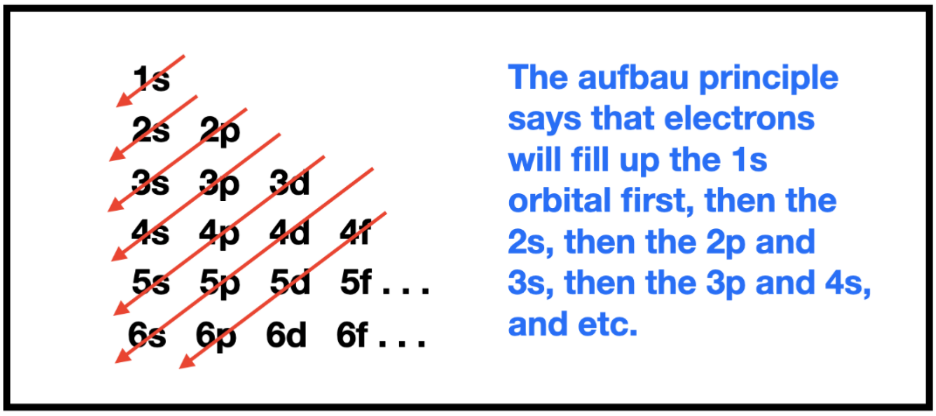


Fig. 6 The *Aufbau* principle explained.

So far, we have been discussing the standard QM model for the first three shells of hydrogen. We segregated variables into the product of a radial function *R*(r) and a spherical harmonic function $Y_l^m(\theta,\phi)$.

It is time now to move to TEW, in which everything is negated.

3.2 The TEW model of hydrogen

In order to transform this QM model of hydrogen into a TEW model, we need to change the "ψ" of Eq. (31) to "$-\psi$" in Eq. (32). This is parallel to what we previously did in Eq. (1).

$$-\Psi(r,\theta,\phi) = R(r)\Big(-Y_l^m(\theta,\phi)\Big) \tag{32}$$

This is the central theme of this article: that the Born rule hides from view the fact that quantum math is wrong, because nature uses negative amplitudes (– ψ) whereas humans use positive amplitudes (+ψ). Proof that nature does it that way will fill the "Discussion" section of this article.

The orbitals of the periodic table become NEGATIVE orbitals. On the right in the next table are the TEW harmonic functions $-Y_l^m(\theta,\phi)$. Note that the signs have been changed in column three, as indicated by the red arrows.

l	m_l	$+Y_l^m(\theta,\phi)$
0	0	$+\sqrt{\frac{1}{4\pi}}$
1	0	$+\left(\sqrt{\frac{3}{4\pi}}\right) cos\theta$
1	±1	$\mp\left(\sqrt{\frac{3}{8\pi}}\right) sin\theta\ e^{\pm i\phi}$
2	0	$+\left(\sqrt{\frac{5}{16\pi}}\right) (3cos^2\theta-1)$
2	±1	$\pm\left(\frac{15}{8\pi}\right) (sin\theta\ cos\theta\ e^{\pm i\phi})$
2	±2	$\mp\left(\frac{15}{32\pi}\right) (sin^2\theta\ e^{\mp 2i\phi})$

l	m_l	$-Y_l^m(\theta,\phi)$
0	0	$-\sqrt{\frac{1}{4\pi}}$
1	0	$-\left(\sqrt{\frac{3}{4\pi}}\right) cos\theta$
1	±1	$\pm\left(\sqrt{\frac{3}{8\pi}}\right) sin\theta\ e^{\pm i\phi}$
2	0	$-\left(\sqrt{\frac{5}{16\pi}}\right) (3cos^2\theta-1)$
2	±1	$\mp\left(\frac{15}{8\pi}\right) (sin\theta\ cos\theta\ e^{\pm i\phi})$
2	±2	$\pm\left(\frac{15}{32\pi}\right) (sin^2\theta\ e^{\pm 2i\phi})$

graphed below

Left: Laplace's spherical harmonic functions $Y_l^m(\theta,\phi)$ **Right:** the negative of them $-Y_l^m(\theta,\phi)$ are used in TEW. The orbitals s, p and d are shown on the left, and –s, –p and –d on the right. The function circled in blue is graphed below.

In order to understand the math, we will take one of the functions from the preceding tables and graph it in polar coordinates. The function circled in blue (above) is the middle "p" orbital. By graphing $-Y_l^m(\theta,\phi)$ we discover that it gives us gives us the same orbital shape as $Y_l^m(\theta,\phi)$ but ***upside down***.

$$-Y_1^0(\theta,\phi) = -\left(\sqrt{\frac{3}{4\pi}}\right) cos\theta$$

The absence of the variable *Φ* means the graph is symmetrical around the "Z" axis. The function (**–** *cos θ*) means the function reaches a minimum and maximum on the Z axis (when *θ* = 0 and *θ* = π) and shrinks to zero at the equator (when *θ* = π/2).

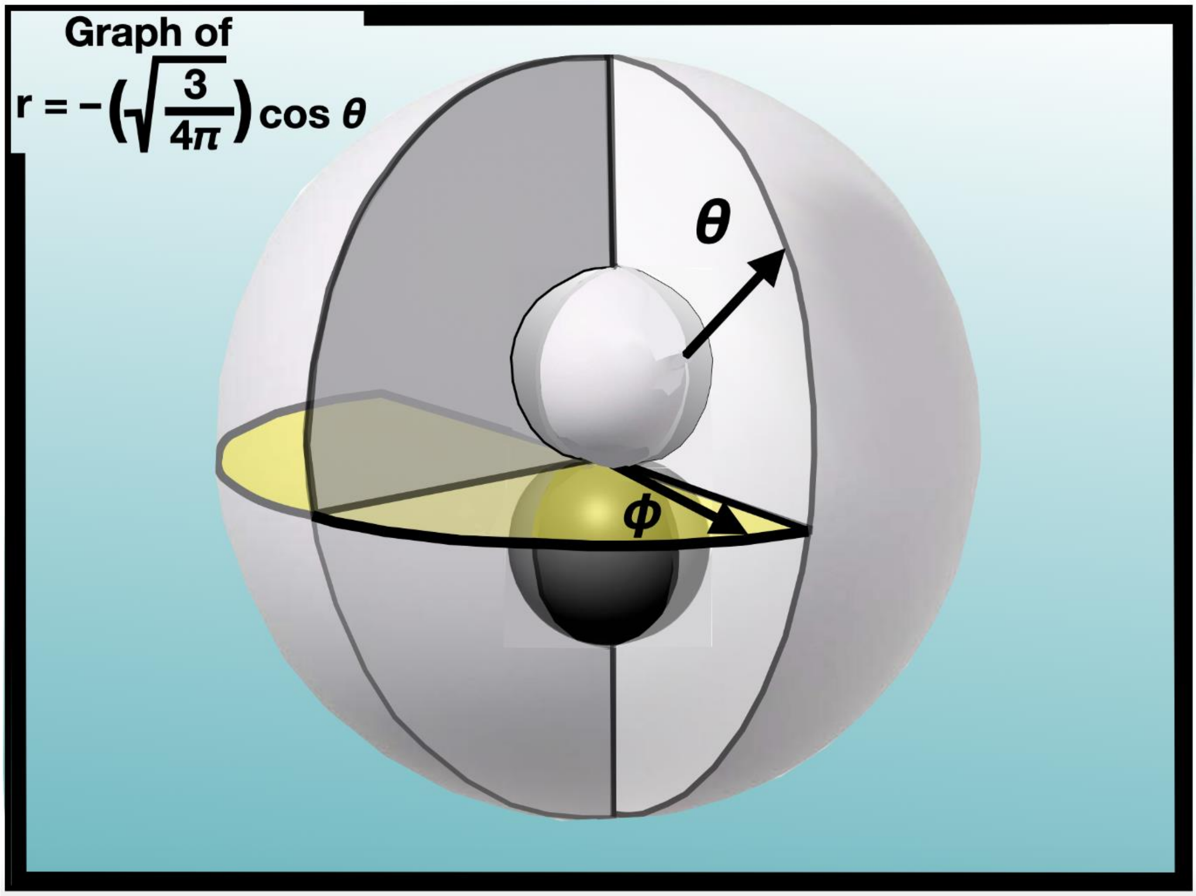


Fig. 7. A graph of $r = -\left(\sqrt{\frac{3}{4\pi}}\right) cos\theta$ in polar coordinates. There is one of these negative orbitals in each period. It can contain up to two electrons (spin up & spin down).

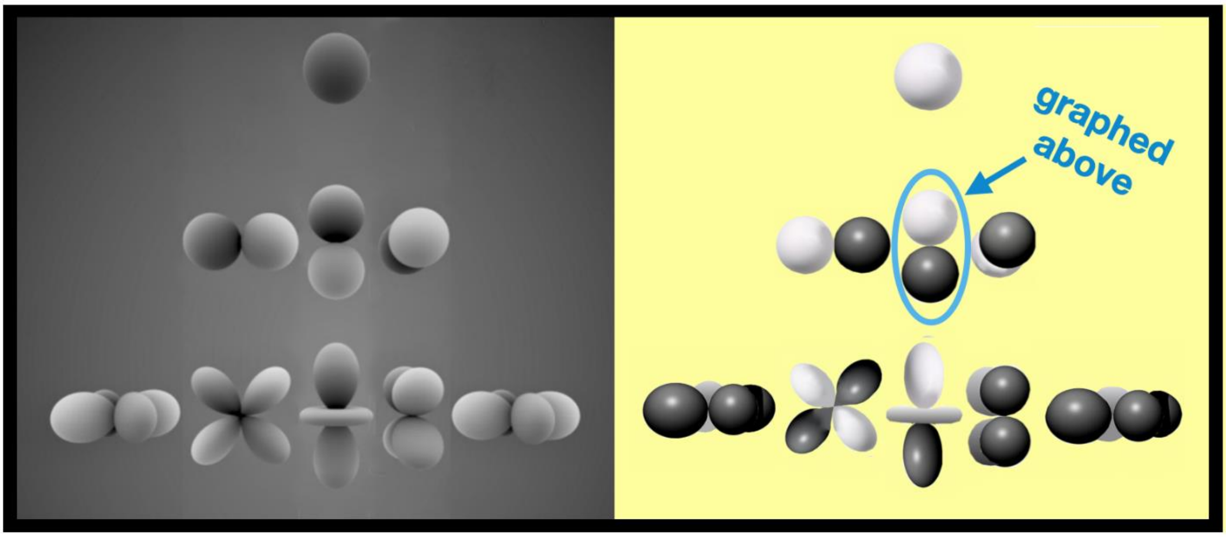


Fig. 8. Laplace's spherical harmonic functions $Y_l^m(\theta,\phi)$ on the left, and the negative of them $-Y_l^m(\theta,\phi)$ on the right. These define the orbitals s, p and d on the left, and –s, –p and –d on the right. The function $-Y_1^0(\theta,\phi)$ circled in blue is graphed above.

What **Fig. 8** is intended to demonstrate is that if you took a photograph of the orbitals on the left, then changed it into a "negative" of that photo, you would discover the negative orbitals on the right. Those areas that are white on the left become black on the right. Black areas on the left become yellow or white on the right.

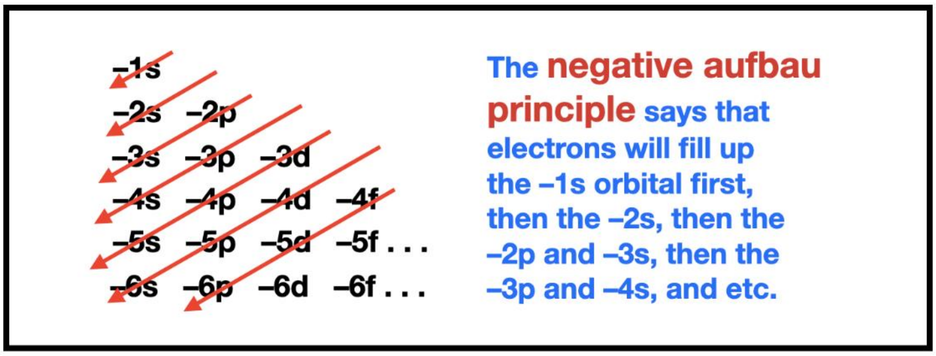
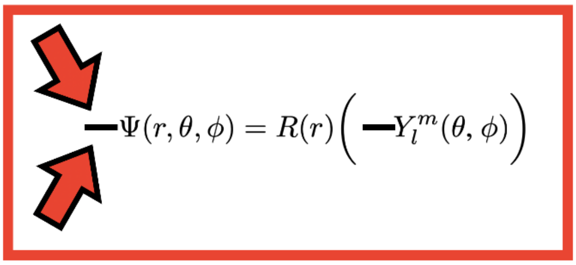


Fig. 9. The NEGATIVE Aufbau principle follows the same pattern as the positive Aufbau principle, which is visible in **Figs. 1, 10 and 12**.

What are we doing when we graph the negative wave function? Never in the history of science has anyone attempted to change the wave function (+ ψ) into a negative wave function (– ψ), and then declare that this is how nature works. Because what we are doing has never been done before, we will work in full public view so anyone can correct the mistakes we will unquestionably make. Einstein said, "Anyone who never made a mistake never tried anything new."

As we said before, the **negative sign (–) does not refer to a negative charge. Coulomb's law has no relevance here.**



$$-\Psi(r,\theta,\phi) = R(r)\left(-Y_l^m(\theta,\phi)\right)$$

Consider the following metaphor. Two companies bid on a contract to string electrical wire across the countryside from town "A" to town "B." They both use the same electrical wire and the same poles and cross arms. The traditional electrical contractor starts at town "A" and strings copper cable across poles toward town "B." The renegade company starts at town "B" and strings copper cable across poles toward town "A." Which one is doing it the correct way?

The traditional company complains that the renegade upstart company is stringing wire in the wrong direction, and therefore the electrical wire will not work properly. "The system cannot carry electricity the same if the wires were rigged up in the wrong direction," they say. What do you think?

Our opinion is that the electrical wires from either company will be equally good at carrying electricity. The analogy is that we have introduced a negative sign (–) into our construction of orbitals, but the orbitals we constructed (– ψ) will carry electrons exactly the same as the traditional orbitals (+ ψ). The negative sign (–) means that we took a different approach to building our electrical system, but the system will carry electrons exactly the same way that the traditional system did.

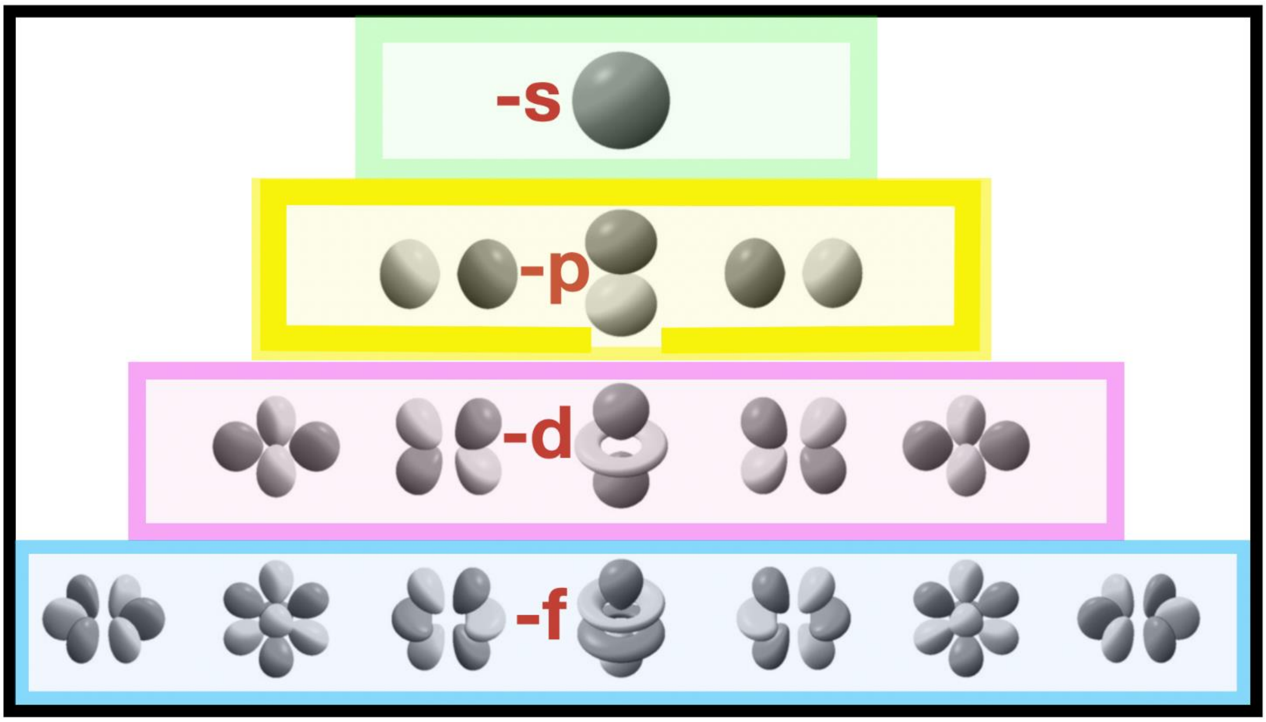


Fig. 10. Color-coding the negative Laplace spherical harmonic orbitals: "–s, –p, –d" and "–f ". This mathematics developed by Laplace in 1782 provides the skeleton upon which we will build a negative periodic table, following the same color codes.

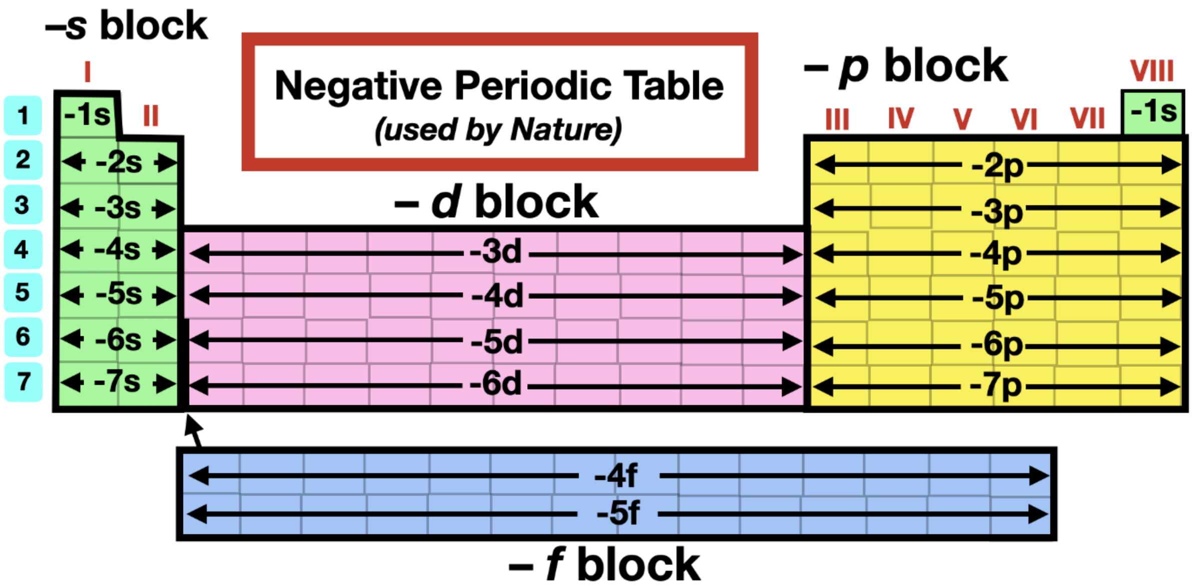


Fig. 11. Arranging the color-coded information from **Fig. 10** into the format of a negative Periodic Table.

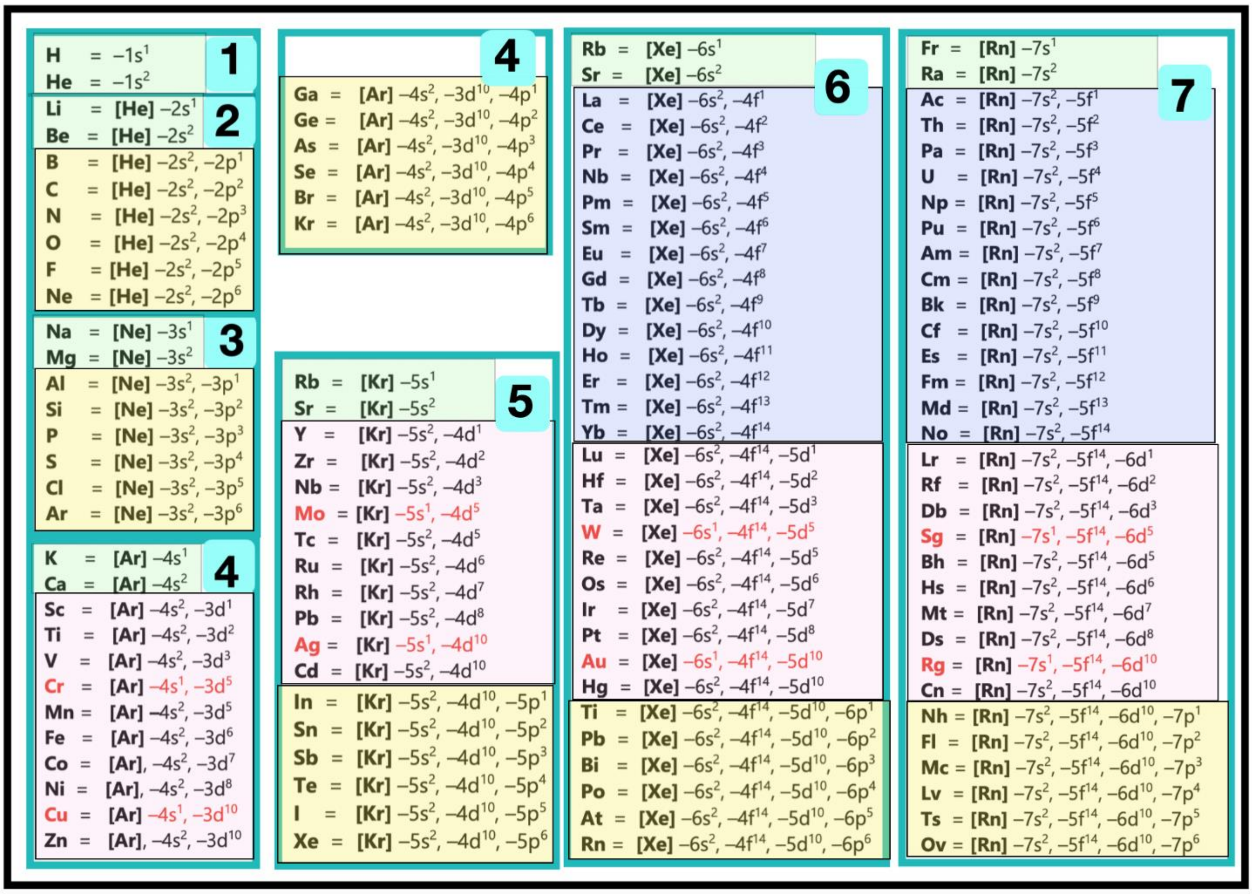


Fig. 12. The negative orbitals of ***all 118 elements***, with the same color coding, ranked according to ***atomic number Z***. The "exceptions" which are noted in red, (such as gold, silver and copper) are due to the fact that under certain circumstances the –d orbital steals an electron from the –s orbital in order to gain stability.

The atoms will have the same number of valence electrons as they have always had (see **Fig. 12**). On a practical level, this change from ($+\psi$) to ($-\psi$) does not change chemistry in any way, as far as how ions, covalent bonds, dipoles or the electron sea in metals.

The hydrogen negative orbitals – ψ (r,θ,Φ) behave like the hydrogen positive orbitals $+\psi$ (r,θ,Φ). They interact with electrons in the familiar patterns.

A solution for the TEW model of the hydrogen atom energy for different energy levels E_1, E_2, E_3, . . . E_n, is:

$$E_n = -\frac{m_e e^4}{8\epsilon_0^2 h^2 n^2} \tag{33}$$

The energy levels of orbitals (in QM) and negative orbitals (in TEW) are the same. (40)

Generalizing what we have said so far, we can see that the entire periodic table has been revised (**Figs. 11-12**), when we change from quantum math to TEW math. All the orbitals have become negative orbitals. Why would we do this? After all the Born rule, ($P = |+\psi|^2 = |-\psi|^2$), means that our probability predictions for experiments would be identical no matter which periodical table we use.

The answer is: this way of thinking would get rid of quantum weirdness. We would be able to visualize and ponder the quantum world with the same clarity that we do the classical world. Our quantum sciences would be liberated from the heavy layers of mathematical fog and would become picturable so that we could use our intuition more easily.

People who understand the quantum world describe it in English, or some ordinary language such as Hindi, Punjabi, Urdu, Farsi, etc. People who don't understand the quantum world use mathematical camouflage to disguise the fact that they don't understand what they are talking about. The mathematical obfuscation allows them to appear to be knowledgeable even though their thinking is muddled. Math can be used for the purpose of intimidating the listeners.

3.3 Clarifications

Two areas of possible confusion need to be clarified. First, all energy and momentum are carried by the particles, none by the elementary waves. Elementary waves are like Schrödinger waves in that they convey amplitudes for energy and momentum. Neither elementary nor Schrödinger waves push nor pull particles. Neither wave does any work. Although they carry an amplitude for energy, both are zero energy waves, meaning they convey no energy. Neither wave equation burns a hole in the paper it is written on.

The second question that people ask is, "**Why** do particles follow waves backwards?" The answer is that we don't know why. We observe that ***this is a law of nature***. We cannot say why nature is universally arranged this way at the quantum scale. Whoever built the universe (ੴ) rigged it up such that this is a law of nature.

4. Discussion

So far, in our discussion of chemical orbitals, we emphasized the difference between (ψ) and ($-\psi$). When we apply that idea to free particles, it becomes the idea that particles follow zero energy waves backwards. That means that wave particle duality is wrong. Our "Discussion" section is devoted to non-chemical experiments that prove this.

The question which way particles travel relative waves was never discussed in the history of quantum mechanics. The founders of quantum mechanics made a mistake in their starting assumptions in the 1920's.

We will review five non-chemistry experiments, to demonstrate that:

4.1 The experiment that allegedly "proved" wave particle duality, proved no such thing;

4.2 An experiment with lasers disproved wave particle duality;

4.3 A neutron interferometer experiment proved that particles follow waves backwards;

4.4 The double slit experiment can only be explained if we reject wave particle duality; and

4.5 If you believe in wave particle duality then you are forced to endorse absurd conclusions about time.

These five experiments lay a foundation for our basic thesis that nature uses ($-\psi$) whereas humans use ($+\psi$).

4.1 The Davisson Germer experiment did NOT "prove" wave particle duality

The Davisson Germer experiments in the 1920's are always cited as "proving" wave particle duality. **Figs. 13** and **14** show the experiment and the data it produced. Electrons were fired at a crystal of nickel, and the angle of refraction was measured. The remarkable part of these data consisted of the "spur" that found in the data when voltage of 54 volts was used (**Fig. 14**). This spur was the focus of discussion in the 1920's and a Nobel Prize for Davisson. The spur was at the angle of 50º which is what would be expected if a wave such as an Xray were refracted through the crystal. **The spur demonstrates that both waves and electron particles are present in the experiment and they interact.** (10,28-30)

That is NOT what the QM leaders said. They said this spur "proves" wave particle duality. They never explained how they made the leap from saying that the waves and particles interact (which is what Louis de Broglie thought) to saying that they were **identical** with each other. They simply asserted it. No one else bothered to look at the data and discover ***that is not what the data said.*** If you stick with the data, all it says is that there are both waves and particles in the experiment, and they interact. The data do NOT say they are different aspects of the same thing.

People see what they want to see. People are blind to ideas that contradict their assumptions about reality.

The Davisson Germer experiment can be explained by TEW. Elementary waves from the detector move backwards through the equipment. They refract backwards through the nickel crystal, penetrate up into the electron gun, and electrons follow the waves backwards to the detector.

This idea was never discussed. If we follow the empirical trail, we are forced to say that the Davisson Germer experiment does not "prove" wave particle duality, and is consistent with the idea that electrons follow elementary waves backwards.

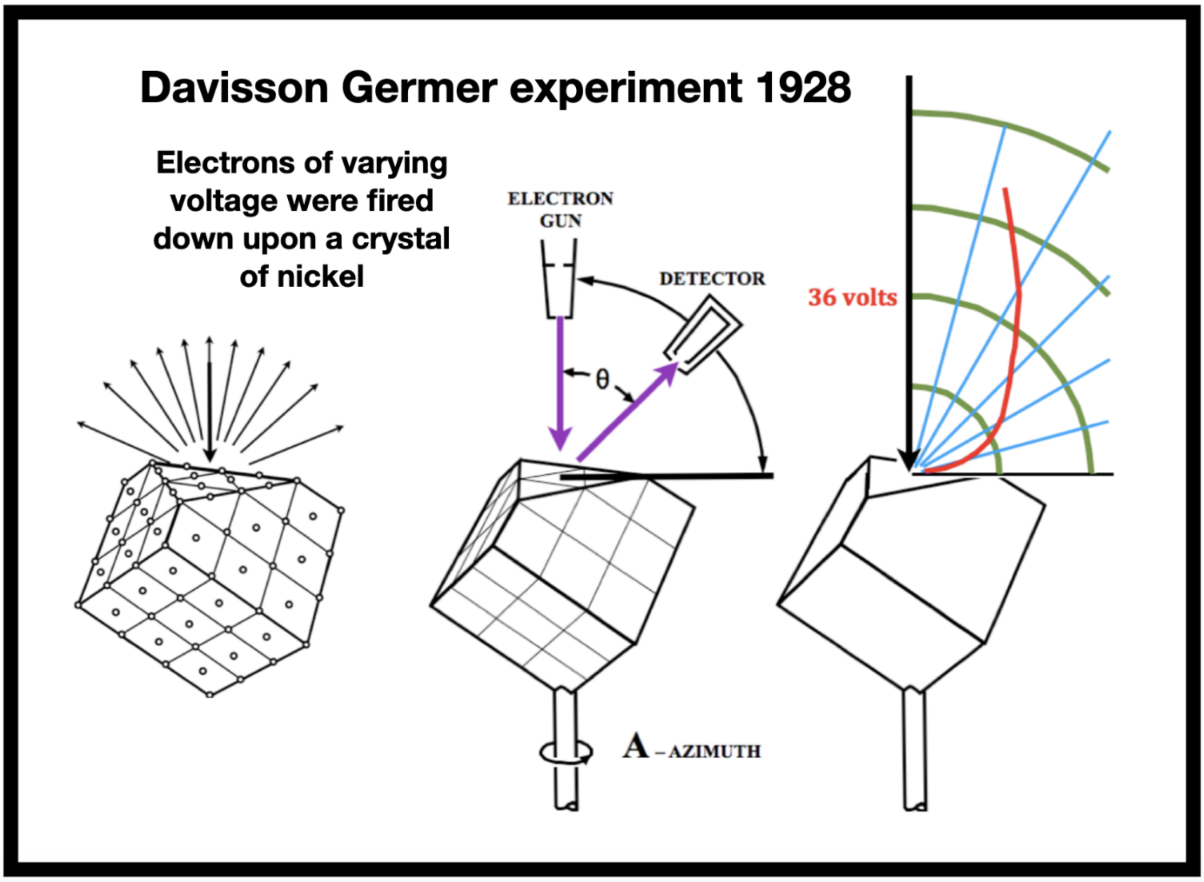


Fig. 13. Equipment of the Davisson Germer experiment.

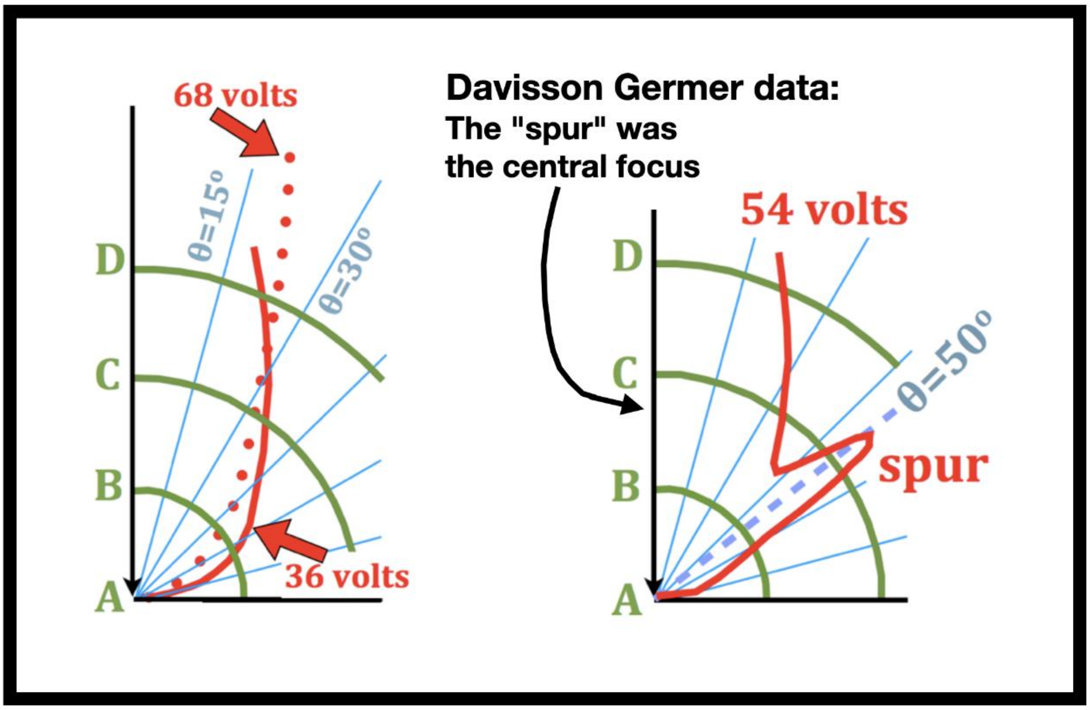


Fig. 14. Davisson and Germer fired electrons at a nickel crystal and observed the angle of refraction. The central focus in the 1920's was on the "spur" in the data.

There are many other experiments, published in mainstream physics journals, that prove that particles follow waves backwards. We will review four of them below. In other publications we have reviewed even more such experiments. (10)

4.2 Pfleegor and Mandel's experiments disprove wave particle duality

Laser experiments of Pfleegor and Mandel are incompatible with wave particle duality. The idea of wave particle duality arises from the double slit experiments. It is often alleged that a particle becomes a wave as it passes through two slits. The experiment described here disproves the conventional interpretation of double slit experiments. (45,46)

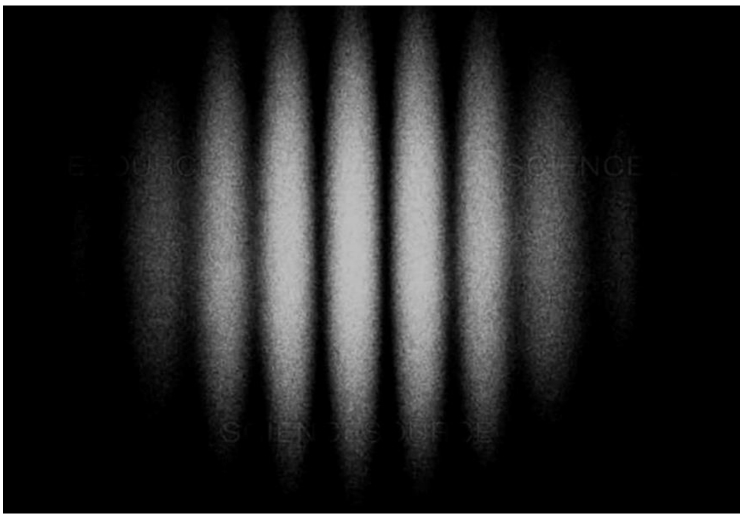


Fig. 15. An interference pattern produced by the intersecting beams of two different lasers.

Think of something like a double slit experiment, but instead of two slits there are two lasers. Clearly, you are dealing with two unrelated photons (**see Fig. 15**).

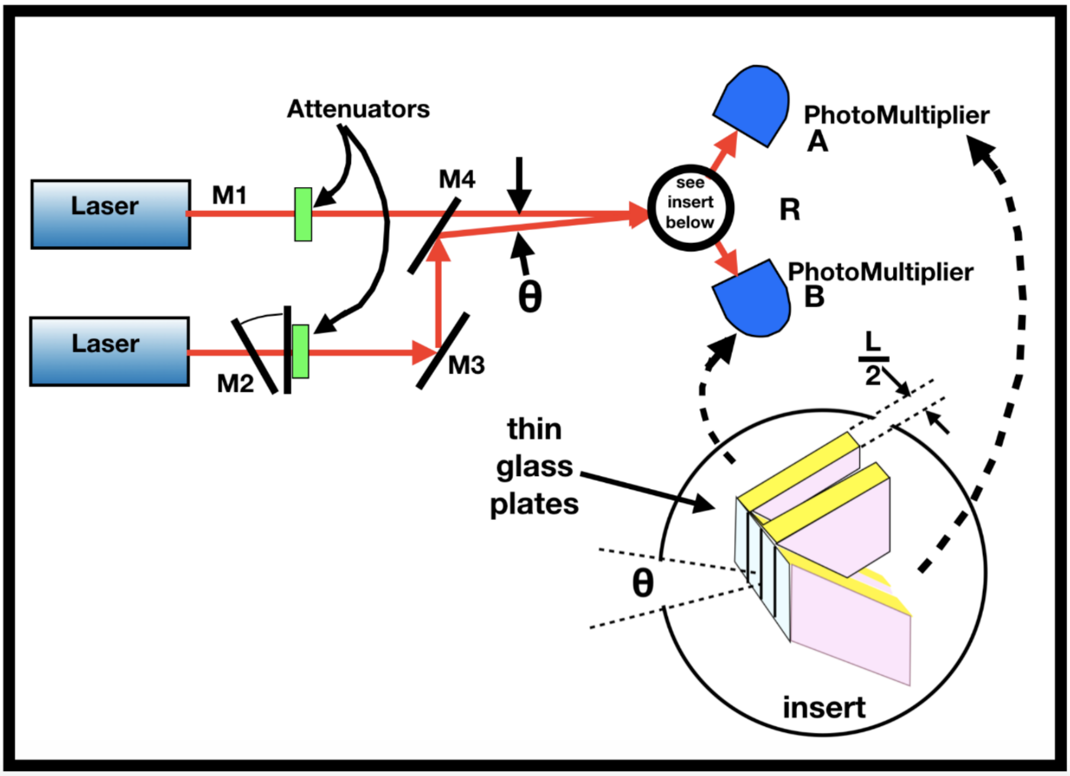


Fig. 15. Equipment used by Pfleegor and Model. Photons come from two lasers on left, and the beams intersect and cause an interference fringe pattern. The "attenuators" decrease the frequency of photons so that almost always there is no photon, or at most one photon, in the equipment at the same time. There are long periods with no photon. Yet the interference pattern persisted even in the absence of two photons!

When the two laser beams intersect, they form an interference fringe pattern: a wave pattern on the target screen (**Fig. 14**). The question arises, where does this wave pattern come from? The experimenters attenuated the intensity of both laser beams, so that there would be one photon followed by 200 times as many nanoseconds with no photon from either laser. The infrequent photons, sometimes from one laser, sometimes from the other, had no probability of two photons being in the equipment at the same time. Therefore, the wave pattern in the final data cannot be attributed to the two photons interfering with one another. Nor can it be said that one photon is interfering with itself, because the photons come from two different lasers.

The experiments showed that an interference wave pattern persisted on the target screen as the lasers emitted photons less and less frequently, to the point that there were never two photons inside the equipment at the same time. The only way to explain the data was to say that the pattern arose from the interference of two zero energy waves (one from each laser). When a photon came along, infrequently, from one laser or other, the photon made the standing waves visible.

How is this incompatible with wave particle duality? A photon passing through the experiment bobs up and down like a kayak in a river with standing waves, but the waves have nothing to do with another photon. The waves are produced by the other laser emitting zero energy "empty waves." The wave particle theory has no way of explaining such a peculiar phenomenon.

4.2.1 Franco Selleri (1936–2013)

The experiments just cited were brought to our attention by Franco Selleri (1936–2013) from the University of Bari, Italy. Selleri defined himself as a rebel in physics against the dominant quantum Copenhagen orthodoxy. He was a professor of theoretical physics at the University of Bari, Italy. He published 350 scholarly articles in leading physics journals, wrote many books and trained many post-docs who are now full professors of physics in Europe. (2,35)

Selleri befriended Louis de Broglie, adopting de Broglie's idea that quantum waves are "empty waves" that interact with particles. Neither Selleri nor de Broglie ever recognized that these zero energy waves ("empty waves") travel in the ***opposite*** direction as the particles. But in other respects, we agree with Selleri's ideas.

Selleri was a maverick, isolated from mainstream physics because of his idiosyncratic point of view. He said, "History teaches that in science, the majority opinion is usually wrong." He was an outcast because he proposed that theoretical physics needed to be based on empirical data, not on a consensus of the leading academic physicists. The Copenhagen interpretation was based on ideology, not empirical data, he said.

The Pfleegor and Mandel experiments were compelling evidence for Selleri's ideas that quantum particles follow zero energy quantum waves. De Broglie applauded and encouraged Selleri's investigations. But these experiments contradicted the Copenhagen interpretation and were therefore ignored by mainstream physics.

Young experimenters told Selleri they were fascinated by his ideas, but they did not dare to conduct experiments to test his theory of "empty waves," because it would risk the future funding of their labs. They said that they were in a no-win situation. If they undertook laboratory studies that might contradict the Copenhagen interpretation, then they would be criticized. If such experiments confirmed the Copenhagen interpretation, then it would be said that they were wasting money because everyone already knew that the Copenhagen interpretation was correct. On the other hand, if their experimental data were incompatible with the Copenhagen interpretation, then their results would be ignored, and they would never get any more money to conduct physics experiments. Therefore, Selleri was unsuccessful at encouraging new research to confirm his "empty quantum wave" ideas. (35)

4.3 Neutron interferometer experiment proves that particles follow waves backwards

Helmut Kaiser and his team published a neutron interferometer experiment that could not be explained by quantum mechanics. When quantum experts claim that QM can explain ALL experimental data, they ignore data like this experiment that contradict QM.

Kaiser et. al. built the apparatus shown in **Figs. 17-18**. Neutrons from a nuclear reactor, came into a neutron interferometer. A silicon blade split them into two streams (ψ_1 and ψ_2). At that bifurcation there was an oscillating aluminum plate that induced a phase difference in ψ_1 versus ψ_2. When the two streams were re-combined in the last silicon blade on the right, there was therefore wave interference, which was seen by the detector (lower right **Fig 17**) as a sinusoidal wave. The height of the sine wave corresponded to the amount of interference inside the interferometer. (5,10,37)

If you would prefer to watch our lively and entertaining YouTube video of 6 minutes, called "Quantum particles follow waves backwards", click here: https://www.youtube.com/watch?v=jPNOUevkuHk&feature=youtu.be

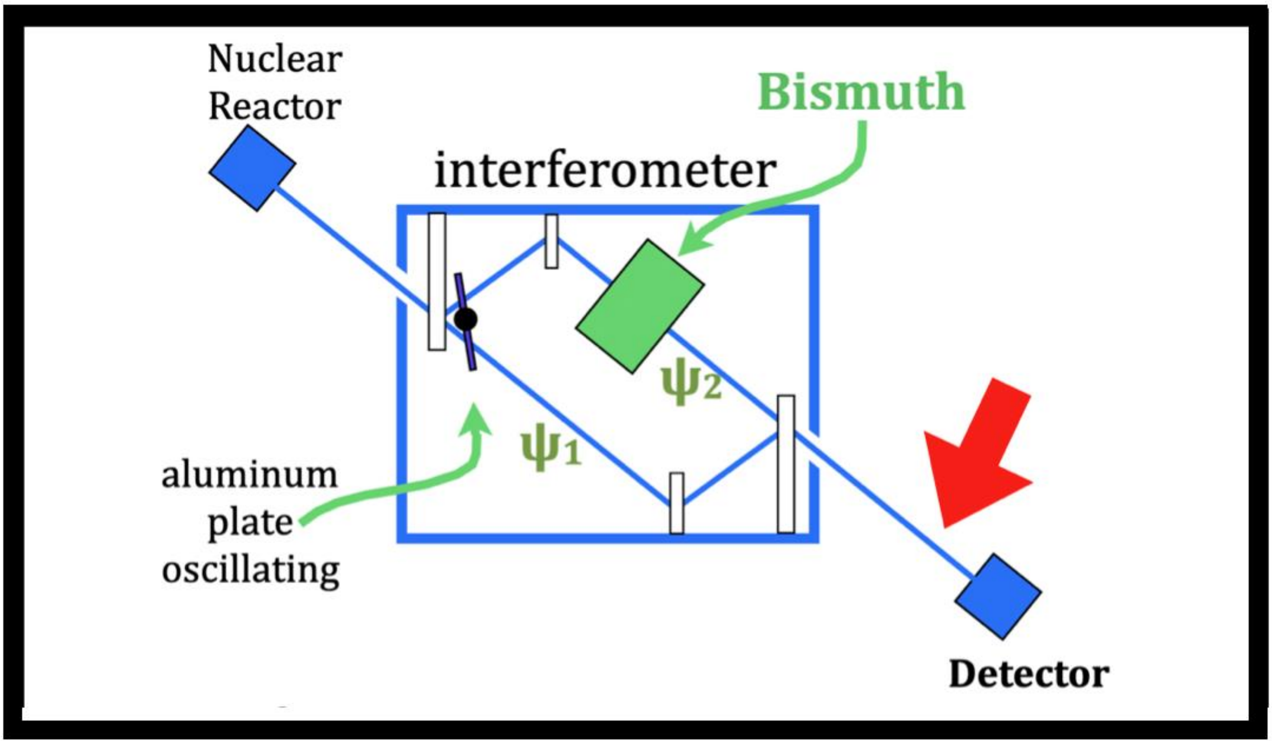


Fig. 17. Kaiser's neutron interferometer equipment, ***without*** a silicon analyzer crystal at the red arrow.

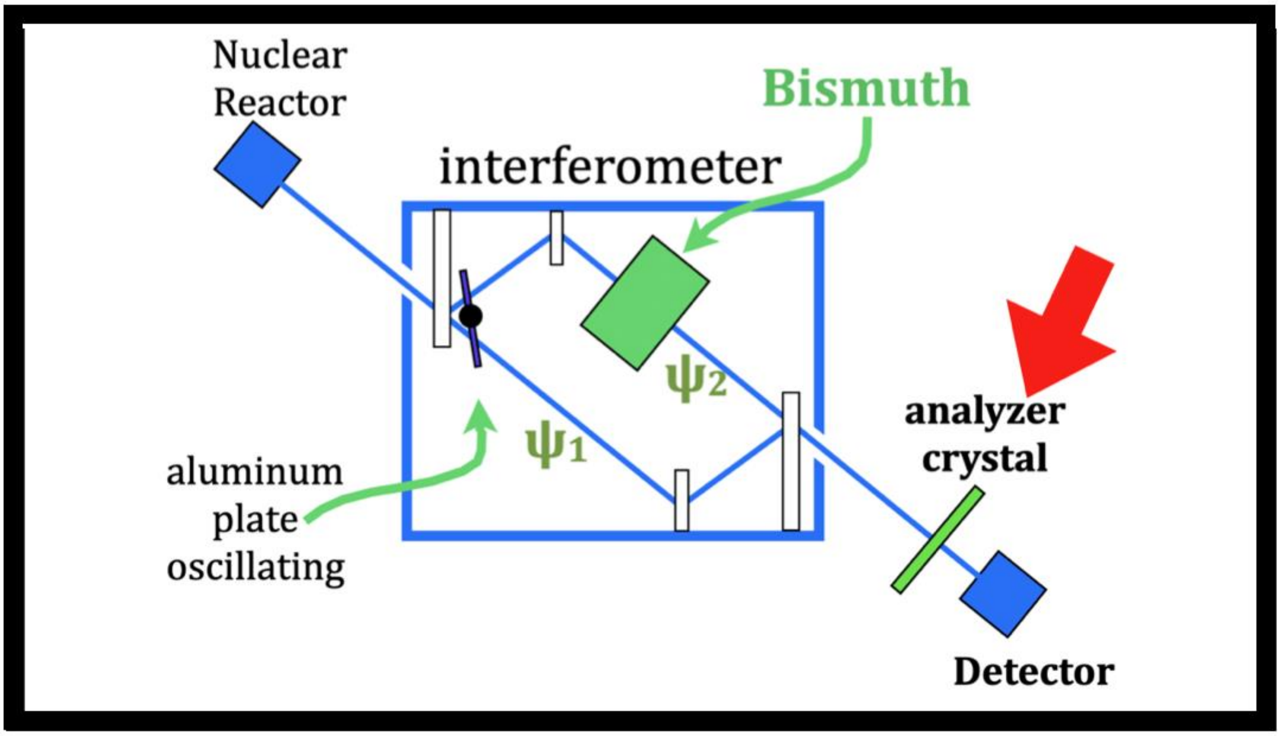


Fig. 18. Kaiser's neutron interferometer equipment, ***with*** a silicon analyzer crystal inserted at the red arrow.

Bismuth is a metal (the 83rd element) which slows down neutrons and neutron waves. When a sample of bismuth 20 mm thick was inserted in the upper stream (ψ_2), the upper wave packet was slowed relative to the lower wave packet (ψ_1), to such an extent that the upper wave packet (ψ_2) missed the boat. The lower wave packet (ψ_1) had already left the interferometer before the upper wave packet (ψ_2) arrived at the reunion point in the right-hand silicon blade. Therefore, all interference was obliterated (i.e. no sinusoidal wave in the output stream). A neutron wave packet has a width of ΔX = 86.2 Angstroms. A sample of 20 mm of Bismuth delays the wave packet by 435 Angstroms.

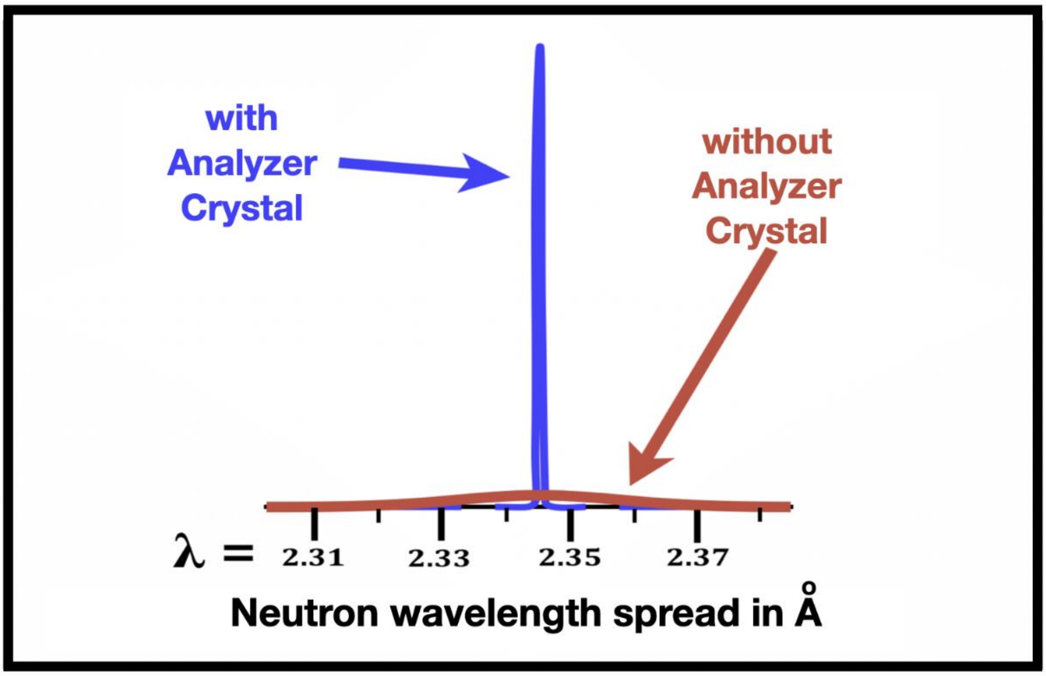


Fig. 18. Impact of the analyzer crystal on the spread of neutron wavelengths: it narrows the Gaussian and focuses it so it should penetrate better. If waves move in the same direction as neutrons, this analyzer crystal should not affect the interference that had occurred earlier, upstream, inside the interferometer.

The researchers then inserted a nearly perfect pressed silicon analyzer crystal as shown (**Fig. 17**), right lower corner), outside and downstream from the interferometer. The analyzer crystal focuses the beam so it should penetrate better (**Fig. 18**). That crystal increases the coherence length of a neutron wave packet from 86.2 to 3450 Angstroms. If QM were correct then the insertion of the analyzer crystal would have no effect on the interference that had already occurred upstream, inside the interferometer. The researchers were astounded with and could not explain the results: **Fig. 20.**

The data (**Fig. 20**) show that the presence or absence of an analyzer crystal in the lower right corner of **Fig. 18** determines the presence or absence of interference upstream, inside the interferometer (**Fig. 20**, bottom row). It is as if the bismuth became transparent to neutron waves!

We say that IF the presence or absence of an analyzer crystal determines the presence or absence of wave interference (Fig. 20, bottom row), THEN the analyzer crystal must be UPSTREAM from the interference. This confirms the central thesis of TEW, that particles follow waves backwards.

This experiment shows that waves and neutrons travel in opposite directions. Elementary waves start at the detector, move northwest through the interferometer, then enter the nuclear reactor and recruit neutrons to follow the waves southeast through the interferometer and into the detector. The detector "clicks" when a neutron strikes it, because neutrons carry mass and energy, but waves carry neither. The elementary waves convey probability amplitudes, but no energy. From the viewpoint of the detector, elementary waves are invisible, and their presence is known only when a neutron makes the detector "click."

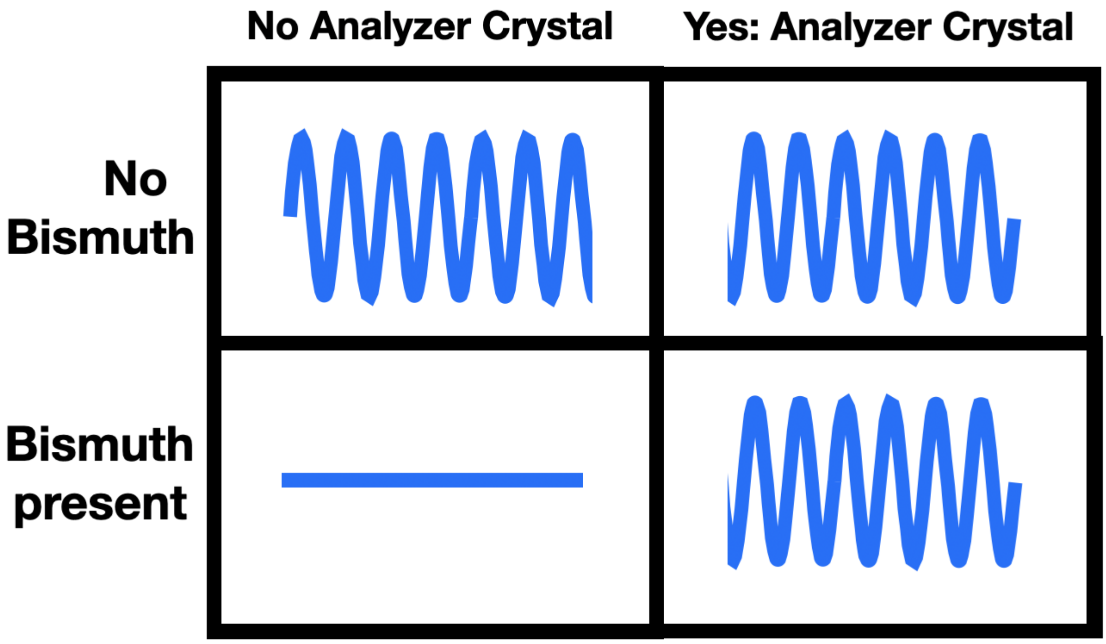


Fig. 20. Final data from the Kaiser interferometer experiment. If the absence or presence of an analyzer crystal (see bottom row) determines the absence or presence of wave interference, then the analyzer crystal controls the interference occurring inside the interferometer. This requires that the analyzer crystal must be **upstream** from the interferometer.

Here is a detailed account of how WE think the neutron interferometer works. Zero energy waves from the detector, move northwest, through the interferometer "backwards" and into the nuclear reactor. All wave interference is located in the upper left corner of **Fig. 18**, between the oscillating aluminum plate, and the reactor. Interference means there is a sinusoidal variation in the frequency of the waves entering the reactor, and therefore a sinusoidal variation in the number of neutrons per second that travel southeast and strike the detector. If a thick sample of bismuth is inserted in the upper stream (ψ_2), it delays the ψ_2 contribution to the interference, therefore there is no sinusoidal wave entering the reactor.

If an analyzer crystal is then inserted, it increases the coherence length of a neutron wave packet from 86.2 to 3450 Angstroms, so that the bismuth becomes transparent. Waves easily penetrate through the bismuth sample, and interference is restored in the experiment.

4.4 Double slit experiment can only be understood if we reject wave particle duality

Many people erroneously think the double slit experiment "proves" wave particle duality. They say a single particle leaves the gun, goes through both slits and causes wave interference, so it is both a particle and a wave.

Einstein was decisive in discrediting that idea. He said that if a particle spreads out and becomes a cloud of probability density, then at that instant when a dot appears anywhere on the target screen, the entire remainder of the cloud would need to vanish instantaneously, faster than the speed of light.

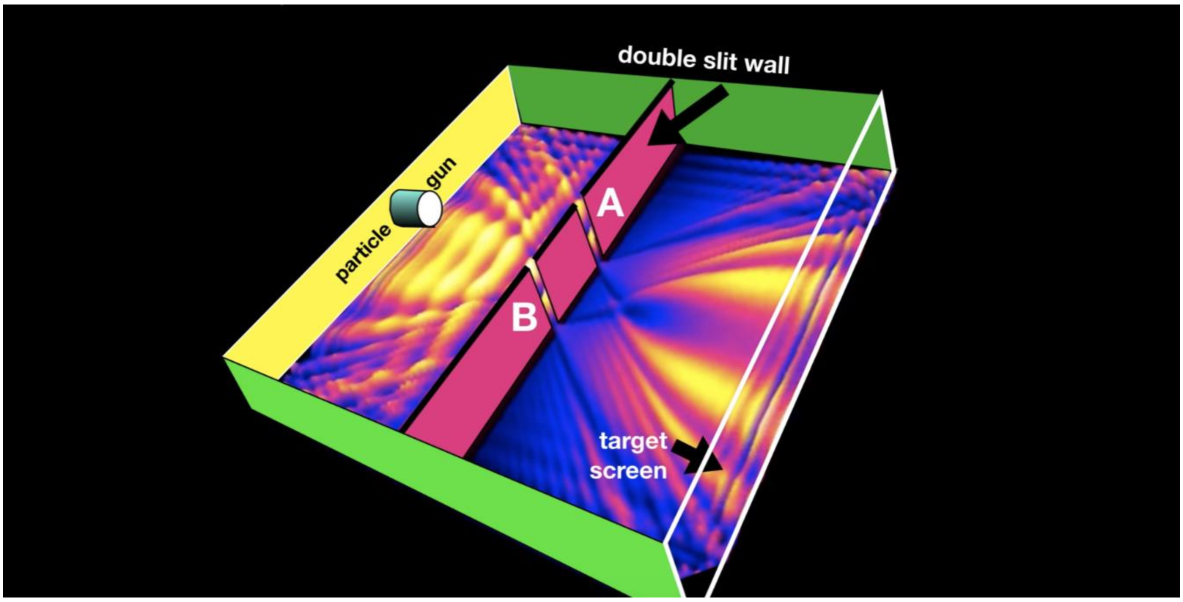


Fig. 21. Computer simulation of a double slit experiment. A wave particle is fired from a gun, goes through both slits and interferes with itself as a Schrödinger wave of probability amplitudes. Einstein said that wave particle duality is only valid if you explain how, at that instant when a dot appears anywhere, the entire wave ***everywhere*** vanishes instantly, faster than the speed of light. In less than one femto-second after a dot appears on the target, the entire cloud of probability on both sides of the double slit wall needs to vanish.

The reason is that 100 % of the probability would then be located at that dot. There would be no excess probability amplitude to distribute through the cloud. If the entire cloud did not instantly vanish, then some other part of the cloud could produce a second dot on the target screen, which would be impossible since only one particle left the gun. (9,14)

No one has ever explained how that could happen. Therefore, ***Einstein won that argument.*** The conventional view of the double slit experiment has been discredited. The only way someone could believe the usual explanation of the double slit experiment is if they can find a solution to the Einstein challenge. No one has.

Richard Feynman repeatedly said that no one can explain the double slit experiment. He called it the "central mystery of QM." Feynman never met this author.

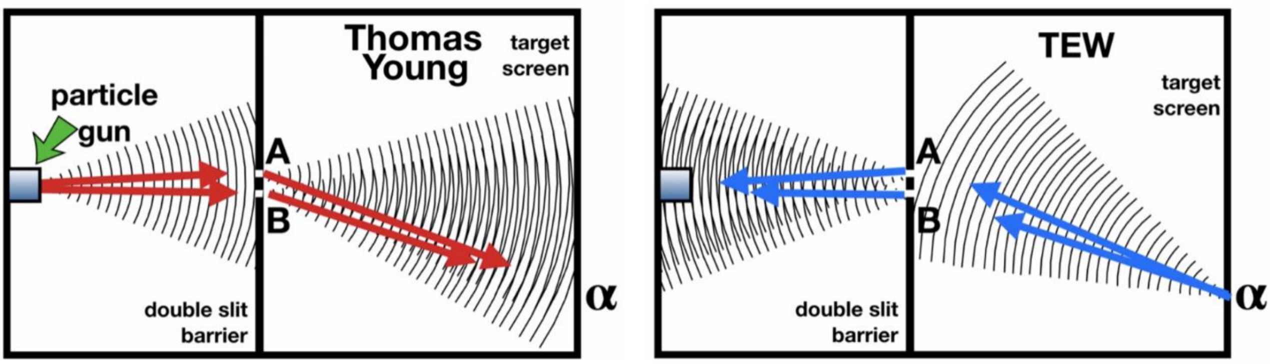


Fig. 22. A comparison of Thomas Young's and TEW's explanation of how a dot appears at point α on the target screen.

TEW can explain the double slit experiment. **Fig. 22** (right) shows that every point on the target screen emanates zero energy elementary waves that penetrate the two slits, moving towards the particle gun. The waves through slits A and B interfere as the impinge on the gun.

Depending on the location of point α on the screen, the wave interference at the gun will be constructive, intermediate, or destructive. The particle, about to be emitted from the gun, randomly chooses one of the incident elementary rays to follow backwards. That random choice is influenced by whether the impinging wave is undergoing constructive, intermediate or destructive interference, which in turn is affected by the original position of point α on the screen.

Once the particle leaves the gun it becomes a deterministic experiment. The particle follows its ray backwards with a probability of one, through only one of the slits (it doesn't matter which slit) and inevitably makes a dot at point α from which its wave is coming.

What we just said explains how the double slit experiment works. Our explanation causes no problems from Einstein's viewpoint.

The next thing we need to do is to explain why our explanation (TEW) produces exactly the same pattern on the target screen as does the Thomas Young explanation. We will do that by making a diagram that ignores the question, "Which directions do the waves travel?" We will then develop a mathematical equation (**Eq. (34)**) that predicts the pattern on the target screen, no matter which direction the waves are traveling.

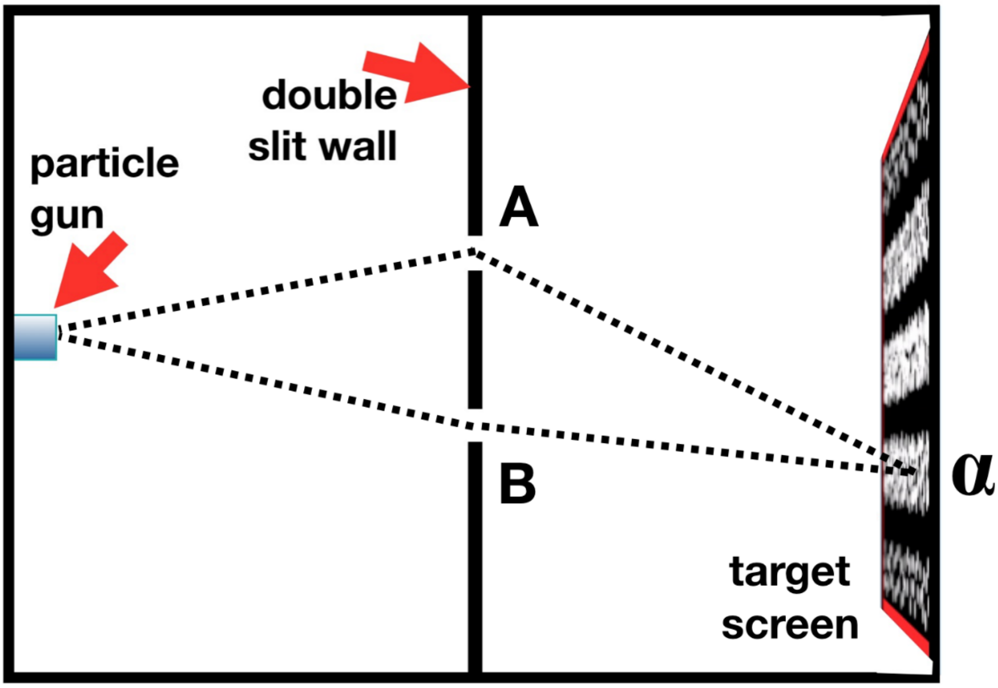


Fig. 23. This diagram compares the length of trajectory "A" to trajectory "B" without asking which direction the waves are traveling.

From **Fig. 23** we learn why the same pattern appears on the target screen, no matter whether the waves are traveling left to right, or right to left. Let "A" be the length of the trajectory from the gun through slit A and to point α on the target screen. Let "B" be the length of the trajectory from the gun through slit B and to point α on the target screen. Let "λ" be the wavelength. Then:

$$\{(A - B) \text{ modulo } \lambda\} \times \left(\frac{2\,\pi}{\lambda}\right) \qquad (34)$$

tells us where the dot is located in the wave pattern on the target screen, measured in radians. The equation does not mention which direction the waves are traveling. In other words, the equation explains why the QM and TEW explanations produce identical patterns on the target screen.

4.4.1 Explanation of "complementarity"

The issue of "complementarity" is easy to explain.

In order for experimenters to know whether a particle uses slit A or B, they need to put a small light and detector inside the experiment, on the side of the double slit barrier that is furthest from the particle gun. To reiterate, for the experimenters to know which slit was used, some source of energy must be introduced into the experimental equipment. No matter how small an amount of energy that is, it is infinitely more energy than the zero energy elementary waves traveling backwards from the target screen, through the two slits.

We discover empirically that this energy destroys the ***superposition additivity*** of the elementary wave penetrating slit A, relative to the elementary wave penetrating through slit B. Therefore, the two waves (from point α through slit A, versus the wave from point α through slit B) can no longer interfere with each other as they impinge on the particle gun. It is as if they are strangers to one another.

What does the wave pattern on the target screen mean? It is a picture of the wave interference incident to the gun. That is what it means.

When there is a small light inside the experiment there is no wave interference at the gun, and therefore the target screen accurately reports, "No elementary wave interference is occurring at the particle gun."

4.5 Quantum eraser experiment forces you to endorse absurd conclusions

Kim, Kulik, Shih and Scully published an experiment that is famous because it demonstrates that IF you believe that waves and particles travel in the same direction, THEN experimental data force you to say that data can be erased backwards in time, which is preposterous. That is our interpretation of what their quantum eraser experiment said. We claim their quantum eraser experiment proves that the doctrine that waves and particles travel in the same direction, leads to absurd, nonsensical ideas. Our conclusion is that this experiment disproves wave particle duality. (10,25,38)

The QM interpretation of this experiment was different. They assumed that wave particle duality was true. They were testing a hypothesis stated by John Wheeler, who had pondered the idea that if you know which slit a particle used in a double slit experiment, then the interference fringe pattern on the target screen vanishes ("complementarity"). He proposed a double slit experiment, in which you would observe an interference fringe pattern on the target screen, ***then at a later time*** discover which slit had been used. Wheeler hypothesized that whenever you learned "which slit" the previously observed wave pattern would disappear, even though the wave pattern had existed before you learned that.

If you would prefer to watch our lively and entertaining 8-minute YouTube video called "There ain't no quantum eraser," click here: https://www.youtube.com/watch?v=anpq-DWC_jU&feature=youtu.be

Yoon Ho Kim's team built the complicated apparatus shown in **Fig. 24.**

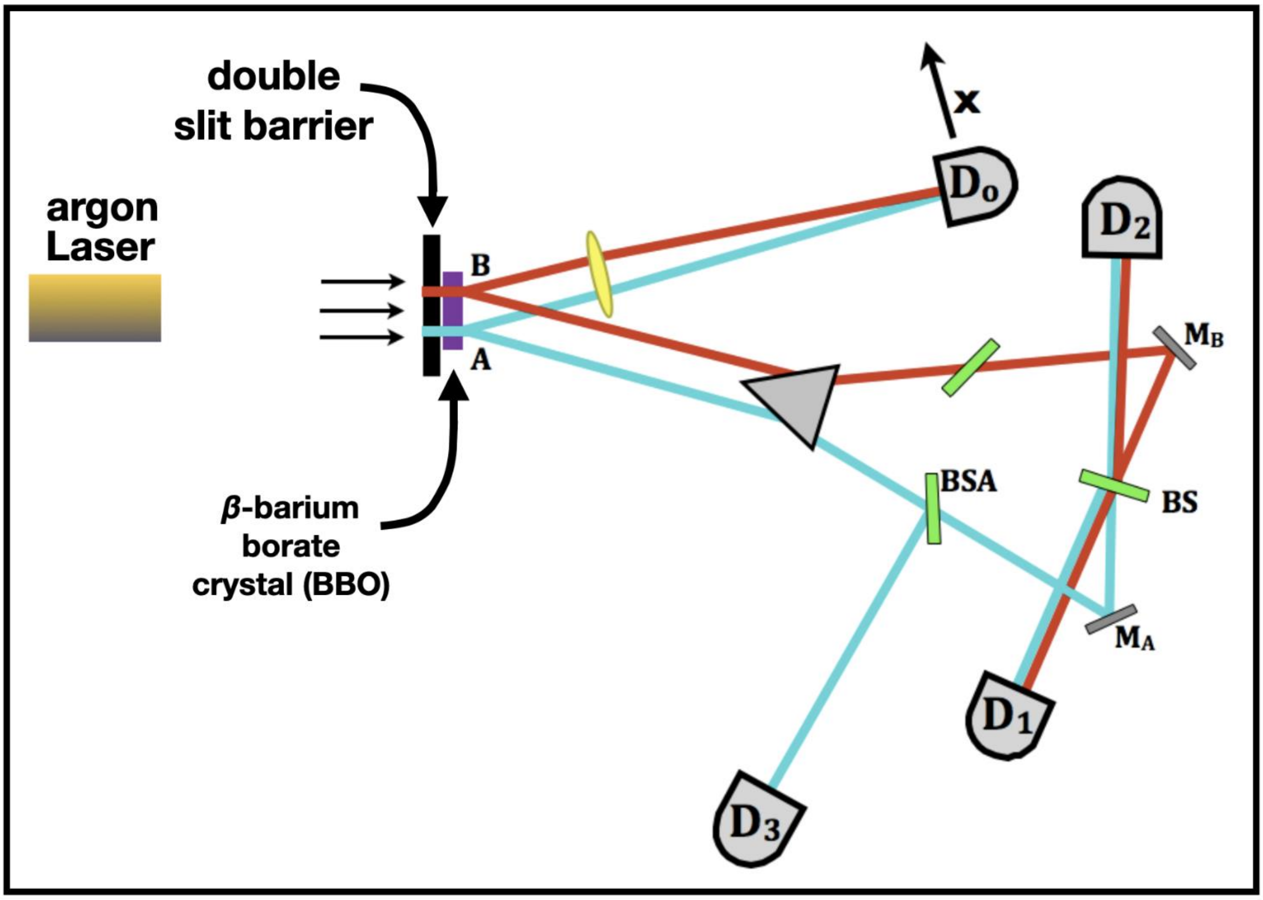


Fig. 24. This is the apparatus built by Yoon-Ho Kim's team. Photons from a laser on the left go through a double slit barrier, and each photon is immediately split into two identical photons by a BBO crystal. One of the offspring is called the "signal" and the identical twin is the "idler" photon. The "signal" photon travels up to detector D_0 where it inscribes a wave pattern on the target screen of a double slit experiment. The other photon travels down to a complex apparatus below (see the next figure).

In **Fig. 24** the trajectories of the photons are color coded depending whether the parent photon went through the top slit B (red) or the bottom slit A (aqua). The terms "BSA" and "BS" refer to beam splitters. "MA" and "MB" are mirrors. The top detector D_0 has an arrow and "x" above it, meaning that it moves up and down the "x" axis to gather the information that would be inscribed on a double slit target screen, if there were such a screen, which there is not.

If a photon strikes detector D_1 or D_2 in the lower zone, then ***we do not know*** which slit was used: notice that both a red and an aqua line enter detectors D_1 and D_2 which means that the parent photon could have come through the upper slit B or the lower slit A. However, if detector D_3 clicks then ***we do know*** the photon came through the lower (A) slit, because only an aqua line enters detector D_3.

A computer assembles the final data from two different detectors: (D_0 and D_1) or (D_0 and D_2) or (D_0 and D_3). The final data show that if the idler photon strikes D_1 or D_2 in the lower zone, then there IS an interference fringe pattern on the target screen (detector D_0). But if the idler photon strikes detector D_3 in the lower zone, then there is NO interference fringe pattern visible on the target screen (detector D_0).

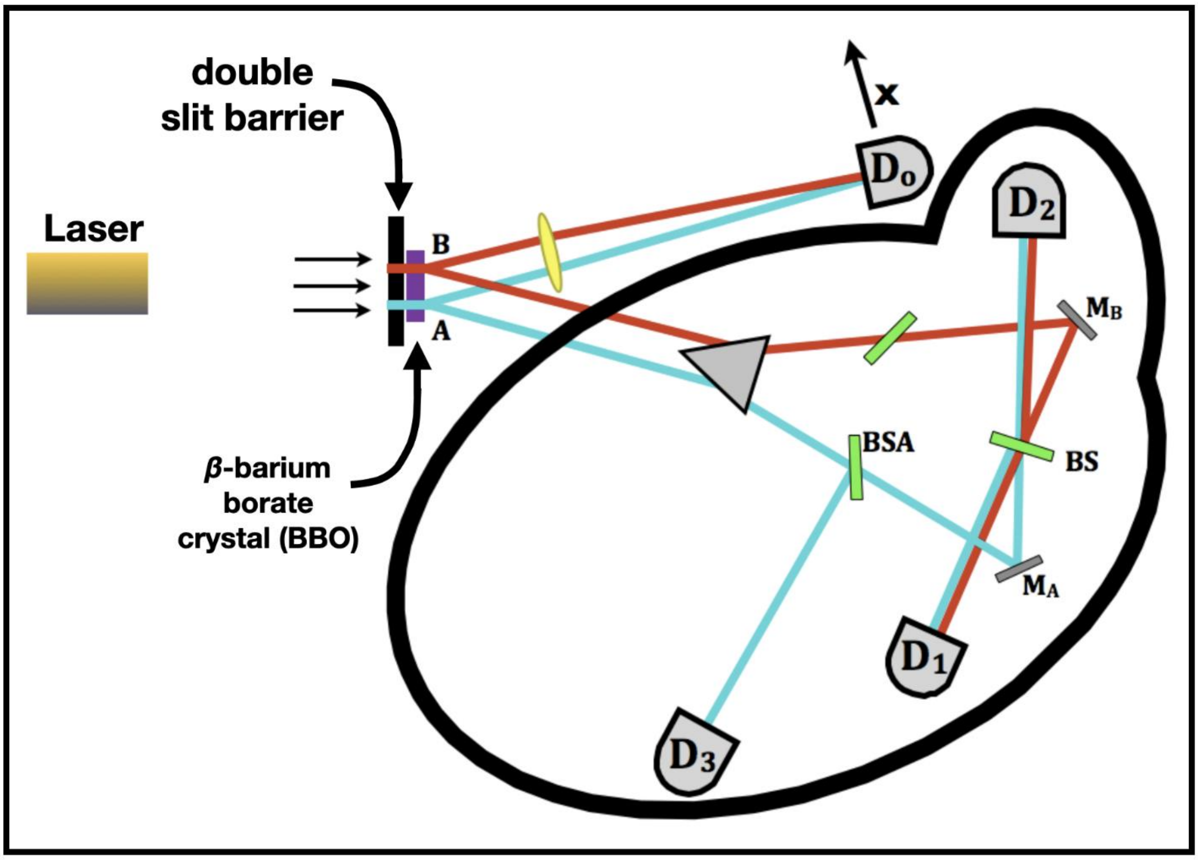


Fig. 25. This is the same as the previous figure, except for the black line which encircles most of the detectors. This complicated arrangement of detectors is more distant from the double slit barrier than is detector D_0. Therefore, these detectors don't "click" until after an interference fringe pattern (wave pattern) has been inscribed on the target screen. The detectors enclosed by the black line, discover or fail to discover which slit the parent photon used. That information, called "which way" information. A beam splitter (named "BSA") randomly decides whether to send a photon to detector D_3 or the other two detectors.

The researchers concluded that they had confirmed Wheeler's hypothesis. They said this experiment PROVES that complementarity is true. Data can be erased data backwards in time. Specifically, if you have a double slit experiment that shows a wave pattern on the target screen (an "interference fringe pattern") and if at a later date you discover or fail to discover which slit was used by the photon, then the wave pattern will be erased or preserved, backwards in time.

An effect precedes its cause. That is what QM claims the quantum eraser experiment proves. Our reply is, "That is nonsense! Complete nonsense!"

Many people have thought about this experiment, and they all get migraine headaches. The experiment appears to mean that the quantum world is so weird, so different from our world, that data can be erased backwards in time.

However, TEW completely changes the meaning of these data.

The QM interpretation of the experiment is demolished if you assume that particles follow waves backwards. The researchers assumed that wave function collapse occurs at the detectors. We assume that wave function collapse occurs approximately 30 nanoseconds earlier: at the laser. After the photon leaves the laser it is a deterministic experiment.

This discussion is like an intricate maze. It worth the tedium of following our argument, because our final conclusion about the quantum eraser is the final nail in the coffin of wave particle duality.

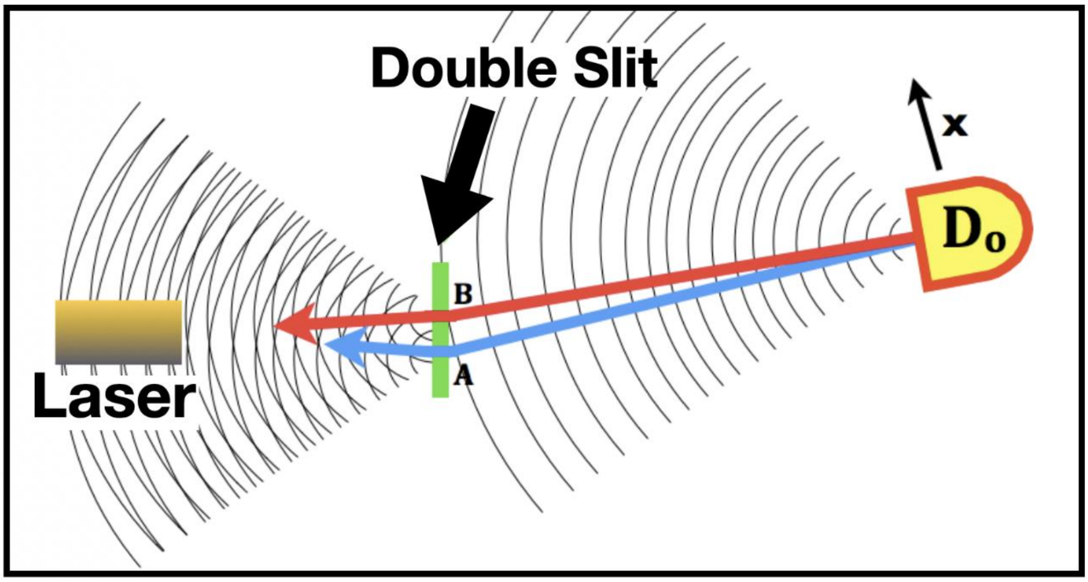


Fig. 26. This diagram is not from the quantum eraser experiment. It is from the right-hand drawing in **Fig. 22.** This shows detector D_0 moving up the "x" axis, which means that it is traversing the face of what would be a target screen, if there were such a screen. Detector D_0 collects data that shows the presence or absence of an interference fringe pattern where a target screen would be. This diagram, like **Fig 22** right, shows the TEW theory that elementary waves start at the detector and move to the left, penetrating the two slits. The waves impinging on the laser through the top slit interfere with the waves impinging on the laser through the bottom slit. Wave function collapse occurs at the laser.

The interference fringe pattern on the target screen in a double slit experiment is a picture of the wave interference that is occurring at the particle source. If there is a wave pattern visible on the target screen, then there is wave interference in proximity to the laser. If there is no wave pattern visible on the target screen, that means there is no wave interference occurring at the laser.

In order to have wave interference at the laser, elementary waves must be using both slits (A and B) as they impinge on the laser. If elementary waves use only the bottom slit (A) then there will be no interference at the laser, because you cannot have interference with only one wave. Therefore, according to TEW, the question of whether there is, or is not a wave interference pattern evident in the final data hinges entirely on whether elementary waves are impinging on the laser from two slits (A and B) or only one slit (A).

This way of thinking leads to an entirely different interpretation of the data.

According to TEW the final data tell the truth. If the final data show an interference wave pattern in a double slit experiment, that means there was wave interference at the photon source. You cannot "erase" that data. If there is no wave pattern on the target screen (at D_0) that means, there was no wave interference at the target screen. The **Fig. 28** shows how that is possible.

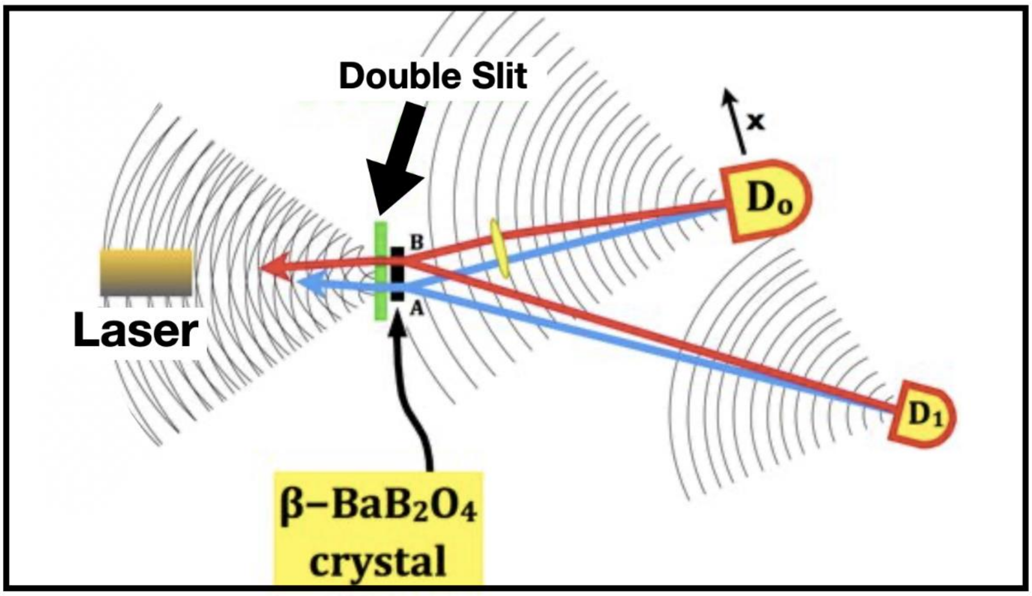


Fig. 27. This shows that four elementary rays merge, in order to produce wave interference at the laser. A red elementary ray of 702.2 nm wavelength from detector D_0 merges inside the BBO crystal with a red elementary ray of 702.2 nm from detector D_1 to form a red elementary ray of 351.1 nm wavelength that penetrates the upper slit (B) and impinges on the laser. Similarly, two aqua colored waves of 702.2 nm merge inside the BBO crystal to form one 351.1 nm aqua wave that penetrates through the lower slit (A) and impinges on the laser. Because both a red and blue wave of 351.1 are impinging on the laser, therefore there is wave interference. Because there is interference at the laser, therefore the final dataset shows an interference fringe pattern.

Fig. 28 shows that any time detector D_3 is involved the final data on detector D_0 will show no interference fringe pattern. This is NOT because the data was "erased." It is because detector D_3 can "see" the lower slit (A) but cannot "see" the upper slit (B). The equipment was designed that way.

If detector D_3 cannot "see" the upper slit, then there is no red wave of 702.2 nm traveling from detector D_3 to the BBO crystal. Therefore, the BBO crystal cannot manufacture a 351.1 nm red wave to go through the upper slit, because half the ingredients are missing. In order to make such a red wave to move toward the laser, the BBO crystal would need to merge two 702.2 nm red waves (one from detector D_0 and the other from detector D_3). Half the ingredients are missing because there is no red wave impinging on the BBO crystal from detector D_3.

Therefore in **Fig. 28** there is no red elementary wave of 351.1 nm traveling backwards through the upper slit (slit B) and impinging on the laser. For that reason, there will be no wave interference, because it takes two waves to interfere with one another.

Now consider the viewpoint of the photon about to be emitted from the laser. The photon is perpetually bombarded by three elementary waves of 351.1 nm:

a) from detectors D_0 and D_1

b) from detectors D_0 and D_2

c) from detectors D_0 (the wave from detector D_3 is absent).

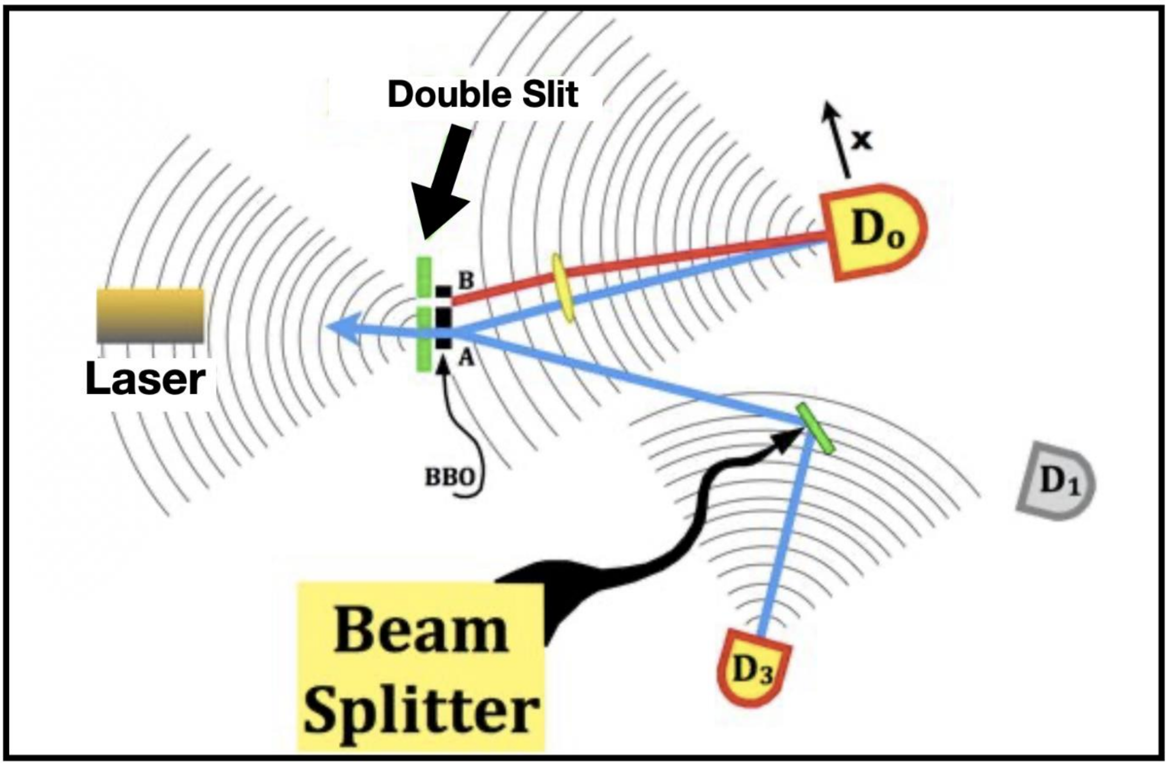


Fig. 28. This diagram shows how it happens that there is no wave interference at the laser, meaning that the red elementary ray of 351.1 nm wavelength is absent between slit B and the laser on the left. The final data in this case will show no wave pattern (a blank screen at detector D_0) because you cannot have wave interference at the laser if there is a blue wave of 351.1 nm impinging on the laser, but no corresponding red wave of 351.1 nm. It takes two waves to make interference.

The photon randomly chooses one of the three. If it decides to follow either of the first two incident waves backwards, then there WILL be an interference wave pattern at detector D_0 because of the existence of wave interference incident to the laser. But if the photon randomly selects the third choice then the final data at D_0 will be blank, because of the absence of wave interference a micrometer in front of the laser.

Detector D_0 simply tells the truth. If there is wave interference incident to the laser, it shows an interference fringe pattern. If there is no wave interference incident to the laser, it shows no interference fringe pattern. At no point is data present and subsequently erased.

We claim to have shown that TEW can explain the quantum eraser experiment in a logical way. We now ask the reader: "If you believe that waves and particles travel in the same direction, what price are you willing to pay to keep that belief? Are you willing to believe that we live in a world in which data can be erased backwards in time?"

5. Conclusions

In this article we proposed that quantum weirdness exists because quantum mathematics (QM) is wrong. Nature uses ($-\psi$) as its wave function, whereas humans use ($+\psi$). Experiments confirm the probability predictions of QM because of the Born rule ($P = |\psi|^2 = |-\psi|^2$). We reviewed some of the substantial evidence that supports TEW and contradicts QM.

Those experiments are not from chemistry. Quantum weirdness does not afflict chemistry as much as it does other parts of quantum science. One reason is that free particles are rarely found in chemistry. Only with a free particle is it possible to dissect out the direction of the particle versus the direction of the quantum wave and discover that they travel in opposite directions.

We have articulated two new laws of nature: 1. (– ψ) is the wave function used by nature, and therefore 2. quantum particles follow waves backwards.

5.1 Significant evidence supports TEW and contradicts QM

What science says about the quantum world is based on empirical data. That data change their meaning if you switch from QM to TEW assumptions. Suddenly the quantum world stops looking "weird" and looks familiar: similar to the world of everyday experience.

The direction of particles versus waves is a toggle switch that transforms the world you live in from appearing grotesque to looking familiar. The evidence changes when you change the sign of the wave function (– ψ).

That is the answer to Mark Twain's complaint ("Truth is sometimes stranger than fiction"). It is true that we made an absurd starting assumption. The proposal that "particles follow waves backwards" is a specific example of the idea that nature uses negative wave functions (– ψ). We paid our weirdness tax upfront. Quantum mechanics, by avoiding paying the weirdness tax, is saddled forever with the penalty of misperceiving the quantum world as if it were weird.

5.2 Paradigm shifts are often rejected when they are first heard

The history of science is a history of paradigm shifts that were rejected by the leaders of science, because the new ideas sounded to them like unintelligible gibberish.

Alfred Wegener is an example. In 1912 he proposed that there had once been a continent named Pangea (he coined the term "Pangea" meaning "All (Pan) Lands (Geo)"). That continent broke apart and the pieces drifted into their current positions as the continents we know today. Every scientist and all scientific scholarly societies denounced Wegener's idea as the most preposterous and stupid idea they had ever heard. Even his father in law criticized Wegener. All leading scientists were clear that there is no force strong enough to move continents across the face of the earth. The existence and breakup of Pangea was not plausible, they said. In the 1920's when QM was being formulated, the idea that gigantic continents moved across the face of the earth was not conceivable. (47)

For half a century Alfred Wegener was not mentioned in textbooks of geology. Then plate tectonics emerged as the dominant paradigm in geology. Today Wegener is cited as the founder of plate tectonics.

It is important to understand why the scientists fight with such determination against a paradigm shift. It is because the new paradigm sounds like meaningless hogwash to those whose way of thinking is calcified in the old paradigm. They cannot distinguish between a brilliant new idea and gobbledygook or rubbish. (39)

5.3 How chemistry changes because of this paradigm shift

We showed the implications for chemistry, namely that nature uses negative orbitals instead of orbitals (**Fig. *12***). On the left side of **Fig. 8** are the s, p and d orbitals from the Periodic Table, but on the right is a negative image that represents the –s, –p and –d orbitals found in nature. Although this sounds profound, on a practical level it makes little practical difference. The number of valence electrons in each element of the periodic table does not change when we recognize that nature uses (– ψ) instead of (+ ψ). Therefore, the electrons bring about the same results in chemistry as they did when we mistakenly thought that electrons occupied positive orbitals.

As we repeatedly say, the negative sign in (– ψ) is not a negative charge. It has nothing to do with polarization of charges, nor with Coulomb's law. It is simply an indication that we used a different mathematics when we constructed our orbitals, like the metaphor of someone who was stringing copper cable across the countryside from town "B" to town "A." The copper wire carried electrons the same, even though the poles and cross beams were constructed in an unconventional sequence.

Here is a short list of things that are not changed when we change our wave function from (+ ψ) to (– ψ): The *Aufbau* principle does not change its pattern (compare **Figs. 6**, **9** and **12**). Molecules arrange themselves in the same pattern as they always did. The octet rule and the rules for drawing dot structures of molecules do not change. Anions do not change places with cations. Molecules do not become their chiral twin. Amino acids and sugars do not change their handedness. DNA does not change to a left-handed helix. Nobel gases continue to act aloof and aristocratic, and do not act like metals. Hydrogen bonding in liquids and the hydrogen line (λ = 21 cm, 1420 MHz) in astronomy are unchanged.

Fig. 12 gives the negative orbitals of TEW for all 118 elements in the periodic table. The table looks dramatic. But chemists are practical people. The shape of the orbitals and number of valence electrons in orbitals are the same, whether we portray the orbitals with a plus, or a minus sign.

The molecular world we live in is the same molecular world we have always lived in, even though our way of thinking about it changes. The world is a mirror image of what QM pictured: nature uses ($-\psi$) instead of ($+\psi$).

Acknowledgement

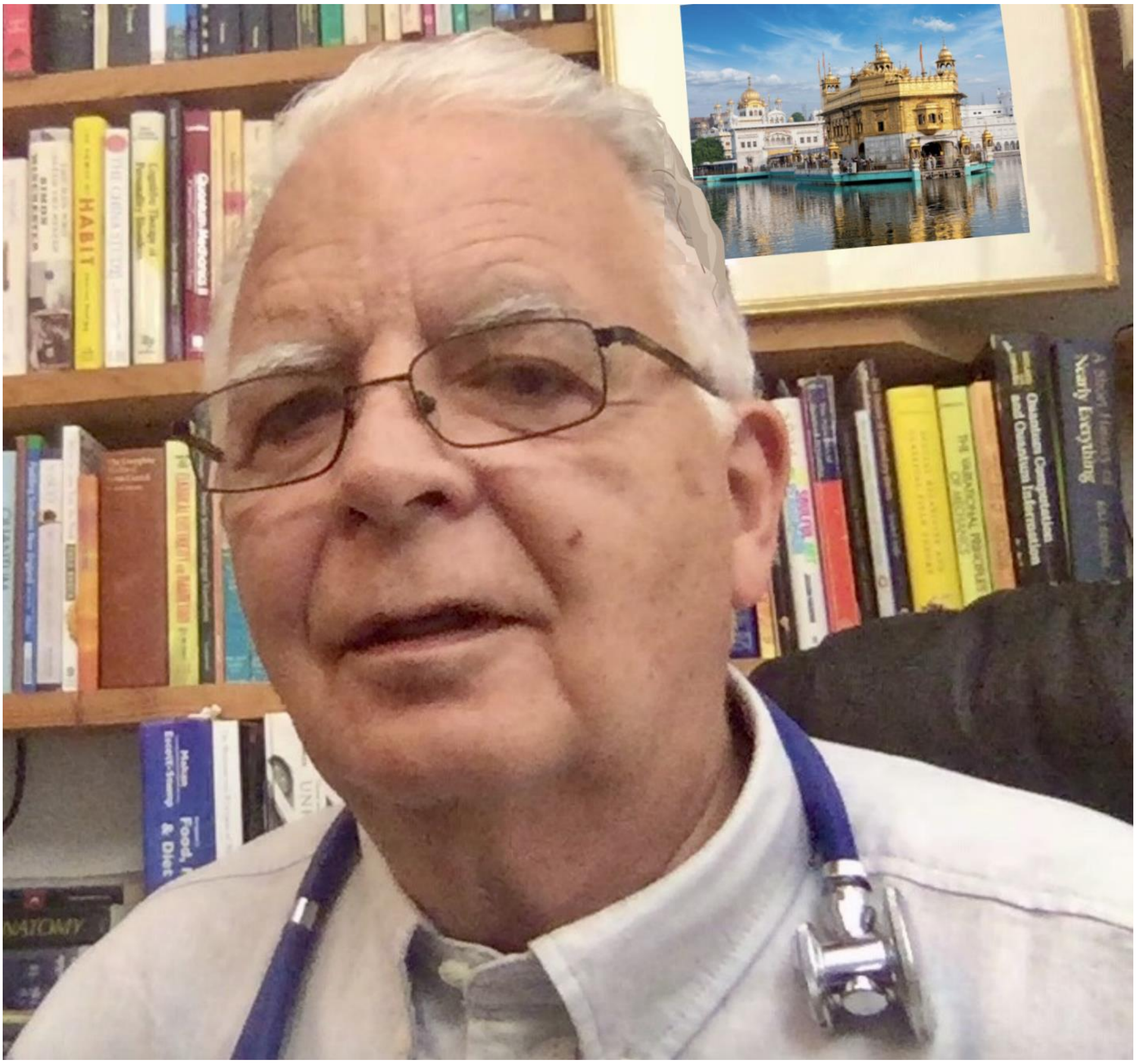
The author thanks Lewis E. Little.

Conflict of interest

The author declares that there is no conflict of interest regarding the publication of this article.

Author Biography

The author was born into the family of a factory worker in New Jersey, USA. His father didn't go to elementary school or high school. The most his father ever earned was $ 9,000 U.S. dollars per year, which is what the family lived on. The author is the first member of his family to graduate from college. He has degrees from Harvard, Yale, Brown and Case Western Reserve Universities. Over the past half century, the author's work and income have been through his practice of medicine. His passion was to care for indigent patients with severe chronic illnesses. But his scholarly research focused on TEW, a radical revision of QM invented by his cousin, Lewis E. Little. Boyd's was sole author of 20 scholarly articles on TEW published in peer reviewed journals of physics, math and now chemistry.



Jeffrey H. Boyd MD, 2020 during the COVID-19 pandemic.

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