Wave-Particle Duality

by William Gray

In 1923 de Broglie proposed that since photons have both wave and particle behaviors then perhaps so do particles. The concept was adopted in Schroedinger's "Undulatory Theory of the Mechanics of Atoms and Molecules" in 1926 which stated that "material points consist of...wave systems." In 1927 Davisson and Germer confirmed the wave nature of electrons in crystal diffraction experiments. And in 1939 Linus Pauling showed in "The Nature of the Chemical Bond" that the electron wave functions form more stable resonance states as pairs than they do as single electron wave functions.

Schroedinger's wave functions were accepted as the basis for chemical bonding because the Linear Combination of Atomic Orbitals by constructive superposition of wave functions explained the bond energies and probabilities and a hybrid combination of the s and p orbitals in carbon yielded a tetrahedral sp^3 orbital that explains organic molecule's structural geometries. The shear magnitude of such agreement between physics and chemistry leaves no doubt as to the electron's wave nature but neither de Broglie, Schroedinger or anyone else has been able to explain the basis of wave behavior.

It turns out that Pauli's Exclusion Principle, Pauling's bond and Einstein's Relativity provide a solution. Pauli's principle simply states that only two electrons can occupy an orbital if they have opposite spins. From a particle perspective this occurs because electron pairs bond by forming an equilibrium between the charge repulsion and magnetic field attraction of opposite spins. And as Pauling showed an electron pair resonance structure is more stable than a single electron which means electrons have a higher probability of occurring in pairs. In chemistry, unpaired valence electrons simply do not exist except during the brief transition region periods that transform reactants into products.

From this evidence it may be surmised that ionized electrons in a monoenergetic beam of a Davisson-Germer diffration experiment would also exist as bonded pairs, since magnetic and charge forces of electrons interact independently from their inertia. So unless a beam is subjected to an external magnetic field strong enough to disrupt the magnetic force between the electron pairs there is no energy in the magnetic domain sufficient to raise the electrons to a non-bonded energy state of unaligned magnetic fields with the exception of thermal kinetic energy which would distribute energy between the six degrees of freedom of a bonded pair.

Linus Pauling addressed thermal energy effects in detail in General Chemistry, Chap. 10, §§10-13, in which he analyzes the six degrees of freedom of diatomic molecules: three translational, two rotational, and the vibrational harmonic oscillation of the radial distance between the nuclei. By the equipartition of energy law, the $\frac{1}{2}mv^2$ average kinetic energy equals 3/2 KT or $\frac{1}{2}K$T per degree of translation freedom of a monoatomic molecule, where K = 1.3805658 x 10^{-24} J/deg is Boltzmann's constant and T is temperature, so v = $(3\ K\text{T} / m)^{\frac{1}{2}}$ for the translational motion of a monatomic molecule.

However diatomic molecules' two degrees of rotational freedom each have a $\frac{1}{2}K$T kinetic energy and their harmonic radial vibration has equal time average $\frac{1}{2}K$T kinetic and potential energies because, by the Virial theorem, for classical or quantum mechanics harmonic oscillators the time average $\frac{1}{2}kx^2$ P.E. and $\frac{1}{2}mv^2$ K.E. equate, where k is the displacement force constant, -kx is the restoring force, and it integrates to a $\frac{1}{2}kx^2$ P.E. over time for a displacement x. So if a harmonic oscillator's total E = PE + KE energy is $2(\frac{1}{2}mv^2)$ and the K.E. of one degree of freedom of energy is $\frac{1}{2}K$T then the harmonic vibrational energy of a diatomic molecule is KT.

This means thermal energy for all six degrees of freedom is 3/2 KT (translational) + KT (rotational) + KT (harmonic) = 7/2 KT for diatomic molecules in their lowest rotational and vibrational quantum states, where the 3/2 KT translational energy and velocity

may vary continuously but the rotational and vibrational energies can only change in discrete KT energy quanta. The $\frac{1}{2}Iw^2$ rotational kinetic energy is the integral of the Iw angular momentum, where w is the radians/sec angular velocity of the diatomic molecule about its center of mass and $I = M_1r_1^2 + M_2r_2^2$ is the moment of inertia of its 2 masses with a $r_1 + r_2$ separation and $r_1/r_2 = M_2/M_1$ ratio. Rotation is stable in $Iw = [J(J + 1)]^{\frac{1}{2}}(h/2pi)$ angular momentum and $E_r = J(J + 1)(h/2pi)^2/2I$ energy value quantum states with a $h/2pi$ fundamental unit of angular momentum and $J = 0, 1, 2, \ldots$ states.

However it is the vibrational harmonic energy that is of main concern here because its oscillation frequency is the basis of the rotational quantum states and it is the relativistic effect of the oscillation energy that causes particle wave behavior. Whether as an electron pair bound in an $F_m = B^2/x^2$ magnetic attraction and $F_e = e^2/x^2$ coulomb repulsion equilibrium an electron and proton pair in hydrogen bound by coulomb attraction and centripetal repulsion, or diatomic molecules bound by their combined effects, each form a negative system energy harmonic oscillator based on the continuous transfer of potential and kinetic energies but which results in the quantum energy states of Schroedinger's wave equations.

As Pauling showed in a harmonic system with equal $\frac{1}{2}kx^2$ PE and $\frac{1}{2}mv^2$ KE, radial displacement varies by a $x = a \sin 2 pi f t$ wave function, where a is amplitude and f is frequency of oscillation, the restoring force constant is $k = 4 pi^2 m f^2$, and the energy is $E_V = \frac{1}{2} m (2 pi)^2 f^2 a^2$ because total energy is $E = PE + KE = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 = \frac{1}{2}ka^2 \cos^2(wt + \phi) + \frac{1}{2}mw^2a^2 \sin^2(wt + \phi)$, where ϕ is the 90^o PE to KE phase shift. Since angular velocity relates to mass by $w^2 = 4 pi^2 f^2$ and $\sin^2 \theta + \cos^2 \theta = 1$, the average energy reduces to $E_V = \frac{1}{2}ka^2 = 2 pi^2 m f^2a^2$. And Schroedinger's wave equation for a harmonic oscillator yields $E_V = (v + \frac{1}{2})hf$ allowed energy values, where $v = 0, 1, 2, \ldots$ is the vibrational quantum number.

This means that the harmonic oscillator has an $E = \frac{1}{2}hf$ energy in its lowest quantum state and never ceases vibrating since, by

the Born-Oppenheimer principle, a two mass nuclear harmonic system with a center of mass ½ way between them may be evaluated in terms of the $\frac{1}{2}kx^2$ PE of one mass with respect to the other. And since a harmonic oscillator's energy component is $E = E_V - E_{V-1} = hf = KT$ for each quantum energy state it means a direct correlation exists between the $\frac{1}{2}mv^2 = 3/2\ KT$ three degree of freedom translational and the harmonic oscillator's $E_V = (1 + \frac{1}{2})hf = 3/2KT$ first quantum state energies, between the $E_V = \frac{1}{2}hf = \frac{1}{2}KT$ harmonic ground state and ½KT one degree of freedom translation energies and between the $E_V = 2pi^2mf^2a^2$ frequency and the $\frac{1}{2}mv^2$ velocity.

This is Schroedinger's particle in box where the $2pi^2mf^2a^2 = \frac{1}{2}mv^2$ energy yields an $f = v/(2\ pi\ a)$ frequency if a is the radial oscillation amplitude of the harmonic oscillation and (2 pi a) is the wavelength. And since velocity causes an $l = l_o(1 - v^2/c^2)^{\frac{1}{2}}$ Lorentz spatial contraction, and coincidental time dilation, it is easily seen that there is a direct correlation between an electron pair's monoenergetic beam velocity and a relativistic wave effect on space from their harmonic oscillation motion. In essence a $\lambda = (2\ pi\ a)$ wavelength is generated by the electron masses harmonic motion equal to de Broglie's $\lambda = h/mv$ wavelength.

The harmonic oscillation of an electron pair is identical to the electron-proton pair in a hydrogen atom harmonic oscillator with the exception of the proton's mass so a Bohr and Schroedinger analysis may be used to show that wave behavior is a relativistic effect in both electron beam diffraction experiments and in atoms. In a Bohr atom based on a classical orbital model the electron has a constant $\frac{1}{2}mv^2$ KE and an angular momentum of $m_evr = h/2pi$ with a k_ee^2/r^2 PE. Since the total energy is E = KE + PE and centripetal acceleration is v^2/r, and centripetal force = coulomb force in a harmonic resonance, $k_ee^2/r^2 = mv^2/r$ and $KE = \frac{1}{2}mv^2 = \frac{1}{2}k_ee^2/r$ so the bound system energy is $E = KE + PE = \frac{1}{2}k_ee^2/r - k_ee^2/r = -\frac{1}{2}k_e2/r$.

Since angular momentum is $m_evr = h/2pi$, the radius for Bohr's $KE = \frac{1}{2}mv^2 = \frac{1}{2}k_ee^2/r$ system is $r = (h/2pi)^2/m_ek_ee^2 = 0.529177249$ Å,

the orbital electron's $\frac{1}{2}m_e v^2$ KE is $\frac{1}{2}k_e e^2/r$ = 13.605698 eV and its velocity is $v = (k_e e^2/rm_e)^{\frac{1}{2}}$ = 2.187691414 x 10^6 m/s which is 0.007297353072 c. The $m_e v^2$ to $m_e c^2$ relativistic energy ratio in the $(1 - v^2/c^2)^{\frac{1}{2}}$ Lorentz Transform factor is $(0.007297353071)^2$ = 5.325136 x 10^{-5} which is 27.21139584 eV of the m_e = 0.51099906 MeV electron rest mass and exactly twice its 13.605698 eV orbital KE. This 27.2114 eV relativistic energy causes a time dilated spatial contraction that is a negative energy well with respect to the KE so the electron has a 13.605698 - 27.2114 = -13.605698 eV state.

In Bohr's model the orbital velocity derives from the radial coulomb acceleration so the relativistic effect is in the radial direction and causes a time dilated contraction of the system mass center toward the electron. Since laws of physics are the same in all inertial reference frames the electron doesn't change its own position by its own relativistic effect, it changes the proton's. This is seen in the calculation of Neutron Spin in Quantum Dynamic Relativity where the electron's 0.78333 MeV mass-energy increase contracts the orbital radius by 2.531 toward the electron causing a vector sum of the orbital spin 1 moment and 2.531 contraction to yield the neutron's ½-spin resultant vector.

This relativistic offset constitutes a potential energy that persists after the electron continues along its orbital path since time dilation maintains the contraction field. So the proton has an added 27.2114 eV relativistic momentum opposite the electron's 13.6057 eV motion vector. This is a spatial momentum, not a mass momentum, that shifts the proton's position as the electron moves in an opposite direction and because of time dilation the system experiences equal and opposite spatial momentums that cancel over time to yield the massless momentum mass defect of -13.605698 eV.

Bohr's 1-dimensional radial energy analysis was revolutionary but incomplete because it only accounted for an orbital electron's Principal Quantum Energy and could not explain the fact that atoms only have a spin 0 angular moment in their ground state. An orbit

causes a spin 1 moment that points up from the system's center of mass by the Right Hand Rule but atoms require addition of external magnetic field energy to align their orbital magnetons into spin 1 configurations so the orbital electron must either be oscillating through the nucleus or it must be a spherical orbital that cancels its momentums to yield a spin 0 resultant in its unenergized state.

Schroedinger resolved this problem and observed subtle energy differences from the Principal Quantum Energy by incorporating all of the electron's degrees of freedom into a wave equation for each dimension. He did this by using de Broglie's $\lambda = h/p$ wavelength relation for a particle with a known $p = mv$ momentum and reasoned that as it moves along an axis it has an $\Psi(x) = A \sin (2\pi i\, x / \lambda)$ wave function. The x dimension is limited by the atomic orbital's diameter determined by the system's negative potential energy well and since the electron moves back and forth on an axis to complete its orbital wave function it has an $\lambda = 2x$ wavelength.

In short, Schroedinger differentiated Bohr's circular orbital to a 1-dimensional translational motion, as if viewing it from the side, and then integrated this 1-dimensional wave function into a 3-dimensional spherically symmetrical wave function of the radius. In this way each dimension of the electron's translational energy mathematically passes through the nucleus and they integrate into a 3-dimensional spherical orbital wave function that cancels their momentums over time to spin 0. And if de Broglie's wavelength is $\lambda = h/p$ and $p^2 = m^2v^2$ then its $KE = \frac{1}{2}mv^2 = \frac{1}{2}p^2/m = \frac{1}{2}(h/2\pi i a_0)^2/m = 2.179873803 \times 10^{-18}$ J = 13.605698 eV, if $x = \pi i a_0$ and a_0 is Bohr's $(h/2\pi)^2/m_e e^2 k_e$ = 0.529177249 Å radius.

So Schroedinger's wave functions yield the correct energy and angular momentum and are successful in explaining atomic behaviors but they are also incomplete because, given a wave function at one instant, it cannot predict the wave function at some later time so they are discontinuous snapshots of continuous functions. However actual wave functions have real and imaginary parts that represent

the electron's total E = KE + PE energy by Euler's e^{ikx} = cos kx + i sin kx Identity, where kx = 2pi/λ x, so the electron has a P(x) = $\psi\psi^*$ = e^{-2kx} location probability that is a product of its real and imaginary wave functions and is continuous because it conforms to a finite statistical distribution pattern.

In other words, Schroedinger's discontinuous wave functions become continuous orbital probability functions. This is because "The theory of probabilities is at best nothing but possibilities reduced to calculus" (Laplace) and the dimension of continuity is absent from Schroedinger's wave equations but integration of real and imaginary parts recovers it as a statistical continuity. This information loss occurred when Schroedinger differentiated Bohr's 2-d circular orbital to a 1-dimensional wave function and lost the orbital electron's angular momentum information that contained the orientation and phase relation between the electron's KE and PE.

Calculus simply adds or deletes a dimension of information by integration or differentiation. So differentiating a 2-d circular orbital motion to a 1-d translational motion loses the orientation and KE-PE phase relation of a circular motion, and integrating the 1-d oscillation into a 3-d spherical one incorporates the effect of a circular motion with precession but does not retain the spin orientation information so it is only statistically continuous and predictable. And we know that circular orbital motion is involved because the 1-dimensional 2x wavelength must be factored by pi to obtain the correct 13.605698 eV energy and a de Broglie wavelength equal to Bohr's orbital circumference which means the information of the electron's circular motion and angular momentum was lost.

To be absolutely fair, both Bohr's and Schroedinger's efforts were profoundly brilliant and a complete solution might never have been derived without their work, the work of other theorists like Pauli, de Broglie, Heisenberg, Dirac, Planck and Einstein, and the application of their principles by Bragg, Hodgkin, Pauling and in particular Franklin in showing how the structure of matter affects

the behavior of waves in X-ray diffractometry. Were it not for a demarcation between matter and waves shown by their work the cause of particle wave behaviors might have been overlooked.

X-rays have short wavelengths that matter interferes with but does not interact with. If electrons truly had wave natures their waves would constructively or destructively interact with X-rays. Instead the electrons are inert to the X-rays but matter's crystal structure interferes with them like double-slits interfere with light. However long wavelength low energy light "pumps" electrons to high energy orbital states that decay by emitting higher energy short wavelength light. So somehow photons and orbitals interact when they have similar energies but particles and photons do not interact when they have similar wavelengths.

Specifically, Bohr's orbital circumference for a 13.605698 eV electron equals de Broglie's $\lambda = h/m_e v$ = 3.32492 Å wavelength but a 13.605698 eV photon has a $\lambda = hc/E$ = 911.267 Å wavelength 274.07 times longer. A 3.32492 Å wavelength equates to a 3729 eV photon and is closer to X-rays so matter waves and X-rays should interact rather than light waves. Schroedinger orbitals are 3-d composites of 1-d wave functions with Principal, Orbital and Magnetic Quantum numbers based on charge, momentum and magnetic energies that the 3-d electric E, magnetic B and massless momentum energies of long wavelength light interact with. So interactions only occur for comparable energies and not for comparable particle wavelengths.

Bohr derived the correct Principle Quantum energy in a model based on coulomb and orbital angular momentum energies but could not explain a spin 0 ground state. In a proton-electron harmonic oscillator the angular momentums must conserve so $m_p v_p = m_e v_e$ and $r_p v_e = r_e v_p$ for equal $m_e v_e^2/r_e$ and $m_p v_p^2/r_p$ centripetal forces and a v_e = 2.187691414 x 10^6 m/s = 0.007297353072 c electron velocity and m_p/m_e = 1836.152646 mass ratio results in a v_p = 1191.454 m/s and r_p = 28.82 fm proton gyration velocity and radius. But this does not take into account the effects of Relativity.

A v^2/c^2 = 0.000053251 m_e = 27.21139532 eV relativistic energy yields a $\lambda = (1 - v^2/c^2)^{-\frac{1}{2}}$ = 1.000026627 Lorentz mass Transform So the electron sits in a -27.2113952 eV RE well with a classical $\frac{1}{2}RE = \frac{1}{2}mv^2$ = 13.605698 eV kinetic energy that is really $)m_e - m_e$ = 13.606224 eV - 13.605698 eV = 0.000526 eV or 0.003866% over Bohr's ground state energy and causes a 0.00003866 a_o = 2.0458 fm radial contraction since the $k_e e^2/r^2$ charge and $m_e v^2/r$ centripetal forces must be equal and $a_o = (h/2pi)^2/m_e k_e e^2$. But this cannot alter the electron's radial position, since the laws of physics are the same in all inertial reference frames (Principle of Relativity), so the electron sees its mass increase as a relative proton mass decrease that increases its gyration radius about the system's mass center.

Since the proton has a 28.82 fm gyration radius the 2.0458 fm change constitutes a 2.046 fm / 28.82 fm = 7.1% increase in radius that is sustained by an equal 7.1% Lorentz time dilation and which offsets the proton's mass from the system center of mass after the electron moves on along its orbital path, as described on page 5. And the electron's orbital motion results in a $u_B = \frac{1}{2}(e/m_e)\ h/2pi$ magneton that causes an $F_b = qv \times B$ Right Hand Rule torgue on the electron by the proton's time dilated offset position so Bohr's classical 2-d orbital precesses into a 0 spin 3-d spherical one.

And because the m_p/m_e = 1836 mass ratio equals the 0.003866% to 7.1% relativistic effects ratio this time dilated proton offset introduces quantum periodicity by restricting an electron's energy to harmonic multiples as seen in Bohr's and Schroedinger's models. The electron's 1-d radial relativistic effect is the resultant of a 2-d planar orbital motion and causes a 1-d proton radial offset. It constitutes a 1-d potential energy that returns the proton to a classical 28.82 fm gyration around the system's mass center as the time dilation in that dimension decays but this PE manifests as a right angle KE to the electron's 2-d planar motion to give it 3-d spherical motion. Because the electron's motion is 3-d it induces an offset in each of the proton's dimensions that results in a 3-d composite of its 1-d time dilated spatial contractions.

The 7.1% time dilation compounds the 7.1% spatial contraction to a 14.2% effect in each dimension, since time dilation holds the proton offset as the electron continues its motion in the opposite direction, with a $(3 \times 14.2\%^2)^{\frac{1}{2}} = 24.6\%$ 3-d resultant that is ¼ of the proton's gyrational energy and the electron's orbital energy, since their angular momentums are equal. And it is a relativistic electron-proton harmonic resonance threshold potential energy that must be overcome to change the electron's 3-d inertial motion and energy level since in harmonic equilibrium the proton and electron have equal and opposite momentums and affect each others motions.

The space-time contraction-dilation is massless momentum and negative in direction with respect to the electron's $\frac{1}{2}mv^2$ momentum because it offsets the proton mass and holds it in dilated time as the electron moves with opposite momentum to the other side of its orbit where it causes an equal and opposite offset. And since the time dilated offset represents ¼ of the proton's gyrational energy it causes a ¼ orbit phase shift between the offset and electron as its orbit and precession moves it in the other dimensions, causing similar offsets in six degrees of freedom. And this six degree of freedom relativistic resonance results in a Heisenberg Certainty.

It is impossible to simultaneously measure particle position and momentum with infinite accuracy because photons impart energy and distances within the photon's wavelength cannot be resolved. Conversely, if the Uncertainty arises from a wave interaction then not adding it leaves a particle with known position and momentum at least from its local inertial reference frame perspective when its reference points have higher mass-energy according to Bohr's Correspondence Principle. And superposition of equal and opposite waves would leave a particle with a known position and momentum by constructively cancelling uncertainties, as would occur from phase shifted relativistic proton offsets on an orbital electron.

Optical laser traps show this in a bosonic atom Bose-Einstein condensation. Bosons have integral spin and wavefunction symmetry

so they can accumulate with identical quantum states according to Bose-Einstein statistics. Bosonic atoms may be regarded as matter waves with thermal de Broglie wavelengths and position uncertainty dependent on their thermal momentums. Einstein predicted that if the thermal de Broglie wavelength of quantum gas particles exceeds the space between them they undergo phase transition and condense to the lowest energy-momentum ground state with identical quantum numbers, becoming indistinguishable with the same wavefunction.

When thermal momentums are reduced their position uncertainty exceeds interatomic spacing and atoms smear out over their thermal de Broglie wavelengths, overlap, and shift phases so their atomic matter waves coherently vibrate in the same quantum states. This occurs at a rate proportionate to (N + 1) for N bosonic atoms and is the same **Bose** stimulation gain mechanism seen in optical lasers where the presence of coherent photons in the lasing mode captures out of phase photons. And coherence occurs with bosonic atoms if lasers in each degree of freedom impart equal opposing momentums to the atoms so they can attain the same quantum state.

Since the atomic matter waves are coherent they know exactly where they are with respect to each other within the uncertainty of the thermal de Broglie wavelengths and Heisenberg's Uncertainty is converted into a Certainty by the equal opposing wave energies of lasers. And this is what occurs when equal and opposing proton offset resonance energies in each degree of freedom of electron motion cancel the uncertainty they created individually. Because it is a relativistic spatial resonance a wavefunction is created in each degree of freedom from independent observer's perspectives but from an electron's perspective it knows where it is in regards to its much more massive orbital proton by Bohr's Correspondence Principle but the proton cannot know where its orbital electron is because the time dilated offset points to where the electron was.

Since the electron's orbital motion is periodic with respect to the periodic relativistic offset resonance it creates, energy

can only add as Bohr multiples of the electron's angular momentum and it can only appear as a 3-d wavefunction to the proton because the electron has a 3-d orbital motion with respect to the proton's 1-d offset that points to where the electron no longer exists. So Schroedinger's wavefunctions actually describe the electron motion in each dimension of an orbital cycle but not continuously between cycles because his equations do not contain the electron's angular momentum information as described on page 7. They are continuous statistically over time however because the phase shifted offset resonance synchronously interferes with the orbital resonance.

Bohr and Schroedinger were also incomplete because they did not analyze their premise of Planck's Constant as the fundamental angular momentum unit. This was unfortunate because a significant connection between EM waves and inertia was missed as a result. Einstein fathered quantum theory with his Photoelectric Equation, $hf = E_i + \frac{1}{2}mv^2$, where E_i is the electron's ionization energy and $\frac{1}{2}mv^2$ is the KE imparted to it, that showed light to be corpuscles and Bohr extended it to his $E_i - E_f = hf$ and $m_e vr = nh/2pi$ initial and final energies and angular momentums of his quantum mechanical orbitals. However a dogmatic rift between relative continuity and quantum discontinuity ensued which was personal between Einstein's theoretical cause and effect method and Bohr's and Schroedinger's more pragmatic quantum description of matter approach to science.

Bohr believed a particle occupies no definite position until measured - existing only as a blur of probability - and Einstein responded, "Do you really believe the moon is not there unless we are looking at it?" He wrote "Can Quantum Mechanical Description Of Physical Reality Be Considered Complete?" in which he imagined a particle decaying into two equal mass daughter particles flying apart with equal velocities to conserve momentum. If Heisenberg's measurement uncertainty disturbs one particle then the other would be undisturbed and its position and momentum known. This argument was undisputed until 1982 when Alain Aspect constructed Einstein's experiment and seemingly proved Bohr's interpretation.

Alain's experiment was very significant because it showed an unseen connection between progeny particles and had Einstein been alive with his Bose-Einstein condensation understanding he would recognized a connection between EM waves and inertia. Aside from any charge and magnetic interactions there is the matter of their Lorentz interactions. Particles contract space in their direction of motion and similarly dilate it in their wakes. Since they have equal and opposite momentums their dilation fields would interact along the axis between them. And if contracted space dilates time flow dilated space must contract it, which means the communication of events through dilated space exceeds that of observer's space.

So if photon interaction with one particle causes uncertainty by changing its momentum it would also alter its dilation gradient and communicate the uncertainty to the second particle through its gradient at greater than an independent observer's speed of light. This is the Twin Paradox brother on earth aging more rapidly than his spaceship pilot brother in contracted space. Earth's space is dilated with respect to the ship's so time flows faster and events occur faster. And the daughter particles' velocities relative to each other determines their observed Lorentz contractions and the compounded dilation of space and contraction of time between them.

Since the physics laws are the same in all inertial reference frames their separation distance is the product of their classical time flow and velocity and it only takes light speed in this frame of reference to communicate. However independent observer's see a compounded dilation of space between them so it should take longer to communicate. Conversely one may view Lorentz contractions as moving them further away in their observed motion directions while they actually only need a speed of light communication time of the classical separation distance from their perspective. Because of this any uncertainty caused by measuring one particle and changing its momentum is communicated through their dilation gradients at a speed faster than the observer's speed of light which appears to instantly create an uncertainty in the other particle.

This constitutes a relativistic Parity Wave in standing wave form with spatial dilation between the particles and contractions on the propagation axis in front of them, with a wavelength that increases as the particles move apart and energy density along the propagation axis decreases like a Kazoo. And it would have been a short step for Einstein to see a relation between the relativistic wave connecting daughter particles and the phase alignment of atom matter waves when thermal wavelengths exceed interatomic spaces in Bose-Einstein Condensations because both constitute a cancellation of Heisenberg Uncertainties and the creation of Parity Certainty.

Events between daughter particles appear simultaneous because the dilated space seen by observers is real and a momentum change to one particle alters its field and affects the other's relative position at the field's contracted time flow rate which equals the speed of light across the particles' undilated separation based on their classical velocity. This is less than an observer's time to measure a position change over the dilated distance so it appears instantaneous in t = 0 time. And since the particles exist within the Parity Wave, separated only by its dilated space region, their relative energy difference is less than the wave's E = hf energy.

Dilated space constitutes a depleted energy region because a momentum change in dilated space is less of a relative change to a greater distance than it would be in normal space so observers see an energy loss. And since the time needed to transmit the energy change event through dilated space appears to be zero the time and energy disparity between the particles is less than Heisenberg's $dE \cdot dt = \frac{1}{2}h/2pi$ Uncertainty and the Uncertainty seen by an observer in measuring one particle is simultaneously present in the other. They have identical opposing energies and Parity Certainty between them with the same observer Uncertainty in one apparent in both.

And since they originate from a common relativistic reference frame that equally divides their physics laws remain identical and they form an expanding 1-d spin-0 Boson with the speed of light of

their reference frame determining event timing. Parity Certainty also occurs when bosonic atoms condense to the same quantum state. When a thermal wavelength energy trough exceeds interatomic space it is a depleted energy region with a contracted dt time flow rate so events occur faster than in atoms with thermal wavelengths that contract space and dilate time between them. The dE difference in energy is also 0 for atoms in identical quantum states so the time and energy resolution limits are less than Heisenberg's $dE \cdot dt = \frac{1}{2}h/2pi$ Uncertainty and Parity Certainty occurs in coherent atoms.

Bosonic atoms converge to a 3-d boson state and the daughter particles diverge to a 1-d bosonic spin 0 state by maintaining the same relativistic frames of reference in depleted energy regions. Their major difference is that the particles increase the speed of light between them by dilating space observers see and bosons seem to slow light because condensation within a thermal wavelength is a relative space-contraction time-dilation density increase that causes refraction like a gravitational lens. But the significant effect in both cases is the creation of Parity Certainty caused by the relativistic effects from their component's motions.

It was not Quantum Behavior that Einstein objected to, it was the lack of continuity between events that bothered him. And with the Parity evidence of Alain's and Boson Condensation experiments he would have realized with great delight that he could use Bohr's own orbital model to incorporate continuity into Schroedinger wave functions, show Bohr that particles have specific locations even if not being measured, and relate electromagnetic waves to inertia by the Parity created in relativistic wave effects.

Schroedinger simply differentiated spin angular momentum out of Bohr's 2-d orbital model to obtain a 1-d wave equation and then integrated it into a 3-d wave function without electron continuity as described on page 6. And Bohr didn't include Relativity in his model and failed to realize the time dilated proton offset created by the electron's orbital velocity as described on pages 8 to 10.

Bohr assumed a mvr = h/2pi angular momentum without explaining why and Schroedinger assumed a /(x) = A sin (pi x/L) wave nature where L is ½ of the λ = h/p = h/mv de Broglie wavelength but ignored the fact that his wavelength disagreed with the electron's actual Bohr orbital circumference wavelength by 2pi, so h = 2pi mvr. In fact, his equations only agree with an orbital electron's energy if they describe a sine wave momentum as if viewing a 2-d orbital momentum as a 1-d side-to-side harmonic oscillatory motion.

However on realizing the implications of Alain's experiment and its relativistic Parity Wave solution Einstein would have seen Bohr's model with electron relativistic effects on its proton as a solution to the wavefunction discontinuity because hydrogen atoms are bosons. Coherence between bosons in identical quantum states can only occur if their wave functions constructively superimpose. If daughter particles dilate space between them on separation they would similarly contract space on converging. And particles bound by a coulomb force as in Bohr's model would harmonically oscillate in each dimension with just such a relativistic Parity Wave effect that is apparent only to observers.

If one particle was more massive its velocity would be less, conserving momentum, and it would not relativistically affect the lighter particle but the lighter particle's higher velocity would relativistically affect the more massive one as described in 8-10. An electron's 3-d spherical orbital energy could be represented by Schroedinger's 1-d wave equations but the actual wave phenomena is the relativistic proton orbital offset in each dimension. Space contracts and time dilates by so the proton experiences attraction to the electron after it has moved on along its orbital path which is the actual basis of the electron's Heisenberg Uncertainty.

The more massive proton is in the same relativistic reference frame as the observer who sees it as the system mass center so the electron generated relativistic wave actually results in it never being where the proton and observer expect it to be by exactly the

energy and time difference of the relativistic effect. Since the electron's KE in a dimension causes a $dE = E_0/E = (1 - v^2/c^2)^{\frac{1}{2}}$ Lorentz space and time Transform its harmonic orbital oscillation causes an equivalent $ds = 1/1_0 = (1 - v^2/c^2)^{\frac{1}{2}}$ proton offset and a $dt = t_0/t$ time dilation in each of the six degrees of freedom.

This means the ds offset, dE electron energy it equates to, and dt time dilation are resolution limits since the electron sees a classical Bohr radius but the proton sees r-ds, and the electron has a classical orbital time of t = v/2pir but the proton has a dt orbital motion delay so the electron has a dE·dt error in its Bohr momentum and position with respect to the proton in each degree of freedom which takes Heisenberg's $dE \cdot dt = \frac{1}{2}h/2pi$ energy-time form of Uncertainty. Since orbital motion gives it bosonic symmetry in each dimension the Uncertainty cancels over time, like Parity Wave Certainty in daughter particles, and the electron is statistically continuous with a mvr = nh/2pi angular momentum since h/2pi is its fundamental unit of energy-time resolution over an orbit but with predictable position and momentum if Relativity is incorporated.

Since Schroedinger's wave equations define the 1-d momentums of Bohr's classical orbital they are also statistically continuous by the symmetry of relativistic effects. And since the electron's energy equates to the relativistic effects its wave equations also define the time dilated proton offset wave function so energy may only add to an electron in harmonic multiples of the offset's wave function because that is where the relativistic energy manifests. Since the offset is the electron's $dE \cdot dt = \frac{1}{2}h/2pi$ Uncertainty, $dE = \frac{1}{2}h/2pi \cdot dt = \frac{1}{2}hf$, and nh/2pi is the electron's angular momentum that causes the relativistic offset the energy can only add in E = hf quantum increments that maintain electron orbital symmetry or it would violate Heisenberg's $dE \cdot dt = \frac{1}{2}h/2pi$ Uncertainty relation.

In other words, when an E = hf photon interacts with hydrogen it may only change electron orbital KE in h/2pi multiples and it is solely a function of electron relativistic energy effects, not

photon and electron wavelength interaction. Using Schroedinger's own Particle in a Box analysis of an electron bounded by a region of width L equal to Bohr's 0.529177249 A orbital radius and energy barrier of Bohr's -13.605698 eV electron negative energy state, if L is equal to an integral number of ½-wavelengths then $L = \frac{1}{2}n\lambda$ and by de Broglie's $\lambda = h/p = h/mv$ wavelength to momentum relation the magnitude is restricted to $p = h/\lambda = h / 2L/n = nh/2L$.

Then using $p = mv$ to solve for allowed KE values, $E_n = \frac{1}{2}mv^2 = p^2/2m$ and substituting $p = nh/2L$ it becomes $E_n = (nh/2L)^2 / 2m$ so $E_n = (h^2/8mL)\ n^2$ or $E_n/n^2 = h^2/8mL^2 = 134.2828392$ eV/n^2. This is not the correct 13.605698 eV energy unless factored by pi^2 because 2L is not the de Broglie 3.32492 Å wavelength which equals Bohr's orbital circumference. Instead 2L is the orbital diameter and 1-d perspective of the electron's orbital motion so it appears to have a momentum that varies as a ½-sine wave function in a side to side motion as described on page 6. So the actual momentum relation is $p = (n/L)\ (h/2pi)$ and if L is the radius then $pL = mvr = nh/2pi$.

So by Schroedinger's own analysis the electron's momentum is angular and only its 1-d components vary as a wave function. And if its components vary as sinewaves then the relativistic proton ds offsets and dE energies must also vary as sinewaves. And since the electron's orbital is a centripetal-coulomb force equilibrium with a $E = -k_e e^2/2r = \frac{1}{2}mv^2$ energy equal to the proton's then the relativistic offset energy is an electric field energy with a $\mu = \frac{1}{2}(e/m)(h/2pi)$ magnetic moment from the electron's orbital motion. And if the orbital energy changes by E_n/n^2 these relations require an equal electric and magnetic field energy change.

And when the electron sits in its -27.2113952 eV relativistic orbital energy well described on pages 8-9 with a 13.605698 eV KE its energy can only change by $E_n/n^2 = 13.605698$ eV/n^2 which would yield a 3.4014245 eV change to a 17.0071225 eV KE for n = 2 in the -27.2113952 eV well and requires a 3.4014245 eV photon energy with a $\lambda = hc/E = 3645$ Å wavelength. But the de Broglie wavelength for

the orbital electron changes from $\lambda = h/m_e v = 3.32492$ Å at 13.6057 eV to 2.9739 Å at 17.007 eV for a 0.351 Å difference with no close constructive wave superposition relation to the photon's 3645.1 Å wavelength except through interaction of its electromagnetic field energy and the electron's orbital electromagnetic field energy.

The -13.6057 eV electron has a $v = (2E/m)^{\frac{1}{2}} = 2.1877 \times 10^6$ m/s velocity and $t = 3.325$ Å / $v = 1.52 \times 10^{-16}$ s orbital transit time and the 3.4014 eV photon requires 3645.1 Å / $c = 1.21584 \times 10^{-15}$ s to pass through its orbital loop so the electron makes 8 orbitals in the time it takes the photon to pass through it. If the photon passes orthogonally through the orbital it represents a +3.4014 eV energy that transfers from its electric field to the -13.6057 eV electron through its orbital electric field. However the orbital precesses 90° as it traverses ½ an orbital and only spends ½x½ = ¼ of an orbital orthogonal to the photon so energy can only transfer ¼ of each orbital and a photon's electric field is in one quadrant so energy only transfers when aligned with the electron's field.

This means it takes 4 orbital revolutions to transfer each ½ wavelength of the photon's energy and 8 revolutions for the total energy transfer. So the time of 8 precessing orbital revolutions needed to transfer the energy through the electric fields exactly matches the photon's travel time through the orbital region. And since electric field energy transfer matches Bohr's orbital model dynamics modified by the Proton Offset Relativistic Effects (PORE) and resultant orbital precession but the 3645 Å photon wavelength does not relate to the orbital electron's 3.32 Å wavelength it may be concluded that photon-electron interaction occurs by electric field energy transfer and not through wave nature interaction.

In summary it may be concluded that while particles exhibit wave behaviors resulting in a $dx \cdot dp = \frac{1}{2}h/2pi$ position and momentum Heisenberg Uncertainty to independent observers, these behaviors are the direct result of space-time relativistic effects caused by the particle's momentum Relative to the observer. This conclusion

has been reached by showing that:

1) particle wave nature in diffraction experiments results from particles being in bonded pairs, by Pauli's Exclusion Principle, with harmonic oscillations that relativistically affect space in direct proportion to their velocity (pages 1-4);
2) Bohr's analysis did not include proton relativistic effects that cause spin 0 precession, Schroedinger lost continuity by differentiating out electron angular momentum, and his equations only represent 1-d momentum energies, not waves (pages 4-7);
3) photon and electron wavelengths do not match (page 8);
4) Proton Offset Relativistic Effects (PORE) cause relativistic harmonic effects that alter the electron's momentum (pages 8-10);
5) Bosonic coherence cancels the Heisenberg Uncertainty between atoms by eliminating thermal effects and causing the atoms to have identical quantum states (pages 10-12);
6) Relativistic Parity Wave effects between daughter particles causes simultaneous Parity Certainty between them and communicates a Heisenberg Uncertainty in one to the other (pages 12-15);
7) Proton Offset Relativistic Effects (PORE) causes Heisenberg's Uncertainty between hydrogen's proton and electron and results in electron behavior discontinuity while orbital symmetry cancels the Uncertainty and causes statistical continuity (pages 15-17); and
8) Photon and electron interaction occurs by energy transfer via their electric fields in exactly 8 orbital cycles and not by wave superposition (pages 17-19).

Particles are not waves, their momentums cause relativistic wave effects to independent observers and objects, and Einstein was correct. "God does not play dice with the Universe" because his dice are relativistically loaded.