

# Einstein's Last Question: What is an Electron?

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Einstein was queried about the huge numbers of short-lived heavy particles found using high-energy accelerators. Einstein was a careful thinker and replied, "I would just like to know what an electron is." He implied that the pedestrian electron, was more important to science than billions spent on accelerators. Einstein saw the electron as the leading player in the Universe. But it did not behave like a discrete particle. Something was wrong and Einstein knew it.

**Answering Einstein.** This article shows that the electron is indeed the leading player in the universe, deeply involved with the Laws of Nature. We follow suggestions by William Clifford (1876) and Irwin Schroedinger (1989) to reject the discrete-particle electron and replace it with a wave-electron. The Scalar Waves of the electron are the only solution of the only Scalar-Wave Equation in Schroedinger's space. Amazingly, it is found that the wave-electron predicts all the experimental properties of the electron. And, It is the origin of all the Natural Laws, fulfilling Einstein's intuition.

**The Truth of Nature.** In Einstein's mind the electron was the origin of the natural laws that underlie technology. This article carefully examines the evidence for the truth of Nature revealing that his intuition was right. You, the reader, will find many treasured concepts are not true.

## 1. Introduction

**The Problem of the Discrete Electron Seen by Einstein.** The science community believed the electron was a discrete material particle. Einstein had deduced this was impossible because Nature's electron is inseparable from the space it occupies.

This article replaces the discrete material electron with a quantum-wave electron, a solution of the Scalar Wave Equation. The result is a quantum-wave electron based upon only two fundamental principles of Quantum-Space in Nature. This new electron fulfills the proposals by Clifford and Schroedinger. Surprisingly, all the natural laws are found in the wave structure of the electron – as suspected by Einstein.

## 2. Historical Proposals for a Wave Structure of Matter (WSM)

William Clifford (1845-1879), lectured before the Cambridge Philosophical Society, stating: "I hold:

1. *That small portions of space are in fact analogous to little hills on a surface which is on the average flat, namely that the ordinary laws of geometry are not valid in them.*
2. *That this property of being curved or distorted is continually being passed on from one portion of space to another after the manner of a wave.*
3. *That this variation of the curvature of space is what really happens in that phenomenon which we call the motion of matter...*
4. *That in this physical world nothing else takes place but this variation subject to the law of continuity."*

He concluded that the entire physical world (all matter and its motion) therefore all of science and the Universe, was a result of the properties of a new entity, 'space'. This article shows that his analysis of (quantum) space, a century before quantum waves were discovered, was correct.

The discrete electron belief began to be questioned about 1930. The quantum-wave functions only hint at how energy transfer happens. But knowing how was what Einstein wanted. We will see below it is not possible to know unless you abandon the notion of a discrete particle and instead accept that the electron is a (quantum) wave structure. Then waves can transfer energy.

**Irwin Schroedinger**, the father of quantum theory, proposed [1937] to eliminate point particles. He wrote: What we observe as material bodies and forces are nothing but shapes and variations in the structure of space. Particles are just schaumkommen (appearances). He concurred with Clifford and the ancient philosophers, that the space medium is the one substance of everything.

**Albert Einstein** [1950] concluded that space must possess a property that extends throughout space to connect particles. His knowledge of Nature told him that discrete particles cannot exist. He rejected the point particle and Maxwell's field Equations that had become the bible of electrical engineering, writing:

*"The combination of the idea of a continuous field with that of material points discontinuous in space appears inconsistent. Hence the material particle has no place as a fundamental concept in a field theory. Thus even apart from the fact that gravitation is not included, Maxwell's electrodynamics cannot be considered a complete theory."*

**Predicting Natural Laws.** Milo Wolff (1990) using a scalar wave equation with spherical quantum wave solutions, found the Wave Structure of Matter that satisfied Clifford and Schroedinger. That equation successfully predicted the natural laws and the properties of the electron that accord with quantum theory and the Dirac Equation.

**Space is One Substance.** Ancient philosophers and mathematicians such as Leibnitz, Descartes, Spinoza, and Kant asserted using the logic of philosophy that all matter and motion, (the

entire universe) was derived from ONE substance. We find that *Space*, the wave medium of the Universe, is this substance.

### 3. Understanding Energy Exchange

We cannot measure anything in Nature without an energy exchange that tells us something has happened. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer. This rule of nature is embedded in biology and our instruments. Thus, finding the energy transfer mechanism of wave-structures is part of understanding the electron and the natural laws.

**Wheeler and Feynman's Calculation of the Energy Transfer Mechanism.** Wheeler and Feynman (W&F) sought [1945] the mechanism of energy transfer by calculating electro-magnetic radiation from an accelerated electron. This electron generated outward and inward spherical waves and evoked a response of the universe from absorber charges. Their mathematical goal was to verify a formula for radiation force found by Dirac (1932) using in/out quantum waves. Their speculative description of in- and out-waves suggested the quantum wave-electron obtained rigorously below using a scalar wave equation.

**The Electron and the Universe.** W&F's work goes beyond explaining radiation because energy transfer and the motion of matter are fundamental processes of nature. Their concept, that all the absorbers in the Universe contribute to each electron, implies an inter-connection; *Every charged particle is part of the universe and the universe is part of every charged particle.* This implies that each of us, you and me, are connected together as part of the observable universe!

**The Answer to Einstein's Question.** Einstein wished to resolve the disparity between the experimental properties of the electron and the discrete electron model. He did not believe that "God plays dice" according to the uncertainty interpretation of quantum mechanics.

Wolff [1990, 2008] and Haselhurst [2004] explored the Scalar Wave Equation and found that its solutions form a quantum-wave structure, possessing all the electron's experimental properties. It eliminated the paradoxes of quantum mechanics. This is what Einstein wanted to know.

### 4. Solutions of the Scalar Wave Equation

You need not be a mathematician to understand the wave structure of Matter of the Universe; this description below emphasizes major concepts.

**Principle I: The scalar wave equation in Space.** The universe abounds with things that oscillate, such as a violin string and a child on a swing. All have a property in common: Energy of motion is exchanging back and forth with energy of position. This energy exchanging property determines a wave equation whose waves obey the conservation of energy.

There are two possible spherical wave solutions:

$$\text{Outward wave} = \varnothing_{\text{out}} = \frac{\varnothing_o}{r} \exp(i\omega t - kr) \quad (1a)$$

$$\text{Inward wave} = \varnothing_{\text{in}} = \frac{\varnothing_o}{r} \exp(i\omega t + kr) \quad (1b)$$

where  $\varnothing_o$  is a scalar wave amplitude, frequency  $\omega = mc^2/\hbar$ ,  $k$  is the wave number and  $r$  the radius of the spherical waves. Picture the expanding, converging wave as bubbles of energy in Fig. 1.

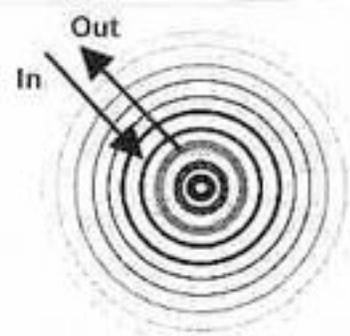


Fig. 1. The spherical waves of the electron or positron

A pair of waves, one converging, one diverging, form a continuous resonant structure in space. The waves of the electron are exactly opposite to those of the positron. Rotations of  $720^\circ$  at the center transform in-waves to out-waves. The resulting spin =  $\pm\hbar/2$ . Thus, superposition of an electron and a positron causes annihilation because Eqn. 2a = - Eqn. 2b.

Four web sites picture the wave-electron in various ways:

1. [www.QuantumMatter.com/see](http://www.QuantumMatter.com/see) pictures wave-electrons - Winston Wolff, Berkeley, California.
2. [www.daugerresearch.com/orbitals/index.html](http://www.daugerresearch.com/orbitals/index.html) shows the H atom waves - Dean Dauger, UCLA, California.
3. [www.SpaceAndMotion.com/Physics](http://www.SpaceAndMotion.com/Physics) gives philosophy of wave-structures - Geoff Haselhurst, Nornalup, Australia.
4. [www.geocities.com/glafreniere00/matter.htm](http://www.geocities.com/glafreniere00/matter.htm) shows electron geometry by Gabriele Freniere, Canada.

These animations display how the in-out waves form a resonance in space around a center. The in-waves formed from all waves from particles in the universe are shown in Figure 2.

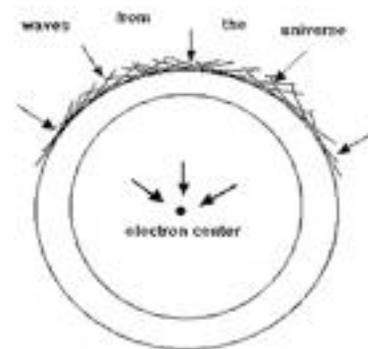


Fig. 2. Formation of the in-wave

The spherical out-waves of an initial electron encounter other electron wave-centers. At each encounter, the signature of the initial electron is transferred to the out-waves of the other electrons. The out-waves generated, become the in-wave of the initial electron. Each particle is a hologram of all others in the universe.

**The Mathematical structure of the electron and positron.** The IN and OUT waves can be combined in only two ways to form the two structures of the electron-positron. These combinations are:

$$\text{electron} = \emptyset_{\text{out}} + \emptyset_{\text{in}} + \text{CW spin} \quad (2a)$$

$$\text{positron} = \emptyset_{\text{out}} - \emptyset_{\text{in}} + \text{CCW spin} \quad (2b)$$

**Spin.** The 720° rotation of the in-wave changes it to an out-wave. This basis of electron spin was first described in work by Wolff [1980] and Beatty-Pratt [1980].

The in-waves reverse direction at the center to become out-waves. This reversal is produced by **CW** and **CCW** (spin) operators on the waves. The operators cause 3D clockwise' or 3D counter-clockwise wave-motion. The in-wave rotates twice changing to an outward wave creating **spin**  $h/4\pi$ , as is Figure 1. The amplitude of the waves and the direction of spin are opposite in the electron and positron. This is why an electron and positron can annihilate each other.

**The second Principle II of the WSM** determines the density of the quantum wave medium – the *space* all around us. This was foreseen by Ernst Mach [1883] who noticed that the inertia of a body depended on the presence of the visible stars. See this in two steps: One, without looking at the sky, visualize a rotating object using the inertia law  $F = ma$  to find circumferential position. Step two, compare the object's angular position with the fixed (distant) stars. Both steps give exactly the same result! Mach asserted: "Every local inertial frame is determined by the fixed stars of the Universe". This is certainly true.

Mach's Principle was criticized because it appeared to predict instantaneous action-at-a-distance across empty space. How can instantaneous travel from here to the stars and back again in an instant? It cannot. It appears so because the energy exchange mechanism, formerly unknown, is the interaction of quantum matter-waves from accelerated matter with the local space of the Universe.

**Principle II postulates that Space density is formed by contributions from waves from every particle in the universe.** In other words, the matter of the universe creates the wave medium in all Space. On a small scale, an accelerated object transfers energy to the waves in the space around it. Accordingly we observe 'space' as the framework of the fixed stars. A simple proof is the laser gyro used in commercial aircraft that behaves exactly as Principle II.

**How is Principle II obtained mathematically?** Wolff [1989] extended Mach's Principle by calculating the density of the wave medium as the sum of the squares of the wave density from every particle in the universe, each diminished by the inverse square of the distance. Knowing the space density you can calculate the velocity  $c$  of the waves, their amplitude and the motion of the wave centers. The velocity  $c$  is almost constant everywhere because there are so many ( $10^{80}$ ) particles contributing waves. However  $c$  varies perceptively when light passes near large masses like the Sun that change the density of Space.

It is important to realize that inertia is an interaction between an accelerated object and its surrounding Space medium. The object is not interacting with the distant stars. The density of the surrounding space is already created by the waves from all the distant stars. This agrees with laboratory gyroscopes and the laser gyros that navigate aircraft. Before knowledge of the Space medium, inertia and gyros were a paradox stated by Newton as: 'action-at-a-distance'.

**Feedback in the Universe.** If you think about Principle II, you will see a strange feedback loop in Nature, as follows: 'The matter of the universe combines to tell the space medium what it is and in turn the medium tells all matter how to behave.' The reader may be inclined to disbelieve this strange result. But there are confirmations, one of which is Einstein's General Relativity (GTR) which contains the same feedback loop: GTR calculates the density of space-time at each point in space using the density of matter and energy everywhere in the universe. This is termed *curvature of space*. Curvature determines the paths of moving matter and light which are influenced by the curvature. Archibald Wheeler expressed this: "All the matter of the universe tells space what it is and in turn space tells matter how it must move." The feedback loop is the same.

This is not surprising because we have already found that all physical laws are a result of the WSM and the space medium. If GTR were not part of the WSM this would be strange indeed.

**Equation of the Cosmos.** A simple calculation [Wolff,1980] yields an eye-opening relationship between the effective radius  $r$  of the electron (as waves), the radius  $R$  of the Hubble universe and the number  $N$  of particles in the universe. This is the Equation of the Cosmos:

$$r^2 = R^2/3N \quad (3)$$

This is remarkable! The smallest thing of the universe,  $r$ , depends on the largest things,  $R$  and  $N$ . This links Mach's Principle, General Relativity, and the ancient philosopher's concept of ONE substance; all are consequences of the Wave Structure of Matter.

**Why can't we feel 'Space'?** We don't sense the space medium because our survival as an animal species depends on our ability to fight with other animals, to seek food, and compete for mates. For survival, it doesn't matter what Space is - it exists nevertheless. As Sir Oliver Lodge quipped: "A fish cannot comprehend the existence of water. He is too deeply immersed in it."

## 5. Origin of the Natural Laws

The wave structure of the electron (Eqs. 2a & 2b) contains the experimentally observed natural laws. The mathematics are derived by Wolff (1980):

1. **Doppler Effect.** A surprising consequence of the WSM is the Doppler effect between two relatively moving wave centers. Say, one is an observer electron and the other is a source electron. Using Doppler math, you can find the **relativistic mass increase, Compton wavelength, deBroglie wavelength**, and the **Schroedinger Equation**. This seems astonishing but it is logical since all depend on relative wave-velocity  $v$ : Find these, by writing two waves, like Eqns. 2a or 2b, for the two relatively moving electrons. Insert the Doppler effect into the inward and outward waves. Then, in each term of the resulting Doppler-shifted wave, you find a **relativistic mass-increase**; that the Doppler wavelength contains the **deBroglie wavelength** and the **Compton wavelength**.
2. **Annihilation of electron and positron** occurs because Eq. (2a) = - Eq. (2b). They are opposite, so all amplitudes cancel.
3. **Spin** occurs because 3D rotation of the in-wave becomes an out-wave (Battey-Pratt, 1960). The two opposite rotations produce the matter and anti-matter of our universe. This is

especially interesting because matter and anti-matter with spin can occur only in a 3D universe. Thus 4D, 5D, etc. universes cannot exist.

4. **Energy Conservation** occurs because wave states that *resonate* with each other must be identical. Being together produces equal and opposite energy shifts. The total energy exchange will follow the relativistic rule above, that contains the familiar energy rule  $E = \frac{1}{2}mv^2$  at small velocity.
5. **Electric charges** occur (as proposed by Schroedinger) because the forces on wave centers behave like point charges. Note: the wavelengths are very small.
6. **Gravity** affects an object because other matter modifies (Principle II) the density of the medium surrounding the object. The changed medium density causes the object's in-wave to speed up.
7. **Inertia**. This is Principle II describing a local force  $F = ma$ . Inertia puzzled Galileo and Newton, but the cause is now clear.

## 6. Conclusion

**The electron is a wave-structure.** The proposals of Clifford and Schroedinger were correct that an electron is a structure in Space. (*schaumkommen*). The Schroedinger wave functions must be interpreted as the electron itself. Wave-particle duality is wrong. The classic paradoxes: wave-particle duality, Copenhagen uncertainty, etc. are caused by the notion of material particles that do not exist.

**Unity of the Universe.** The wave medium, the space around us, is the origin of matter and the natural laws. Since the waves of every particle all contribute to the density of the medium, it follows that: *Every charged particle is part of the universe and the universe is part of each charged particle.*

Principle II (containing Mach's principle) states that the stars and galaxies of the universe underlie the Laws of Nature and the existence of the Earth and ourselves. This important fact is not yet well-known. For example, the present Standard Model of the universe contains no mention Mach's Principle, or our interconnection with the universe.

**Why is the WSM still a radical discovery?** It is tempting to imagine scientists as noble pioneers, questing for the greater good of humanity, transfixed by the amazing Universe. However the history of nearly every radical discovery portrays scientists no different than you or me. This helps us understand why the science community has not yet adopted the Wave Structure of Matter. It will take a long time to dispel the illusions of the discrete particle that leads science down a dead end street as in Figure 3.

Although the pioneers of physics urged their peers to consider waves as the fundamental structure of matter, the temptations of government funding led science down a dead end street searching for discrete particles.

**The Future.** New applications of the WSM will be found in the behavior of matter at small dimensions; especially the quantum world, low temperature, new alloys, bio-physics, molecular computers and memories.

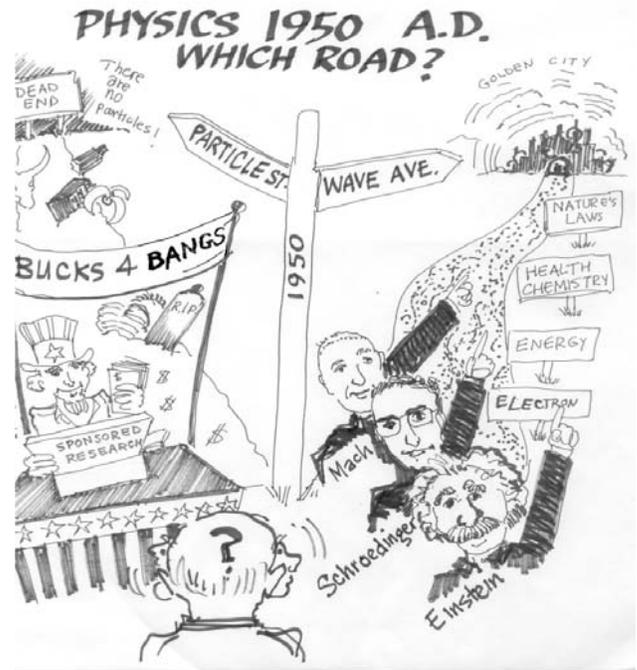


Fig. 3. The illusive lure of the discrete particle

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