

# The One Electron

## **Forward**

This is a transcript from a YouTube video.

Parenthetical and italicized text are mine.

I submit the following for your consideration in your modern understanding of the knowledge that Shakyamuni Buddha was trying to convey some almost 3000 years ago to a largely illiterate people as well as all caste up to the intellectual (*Brahman*) caste of India.

My constant goal is to make the history and scholarship of Buddhism and its founder's teachings as easy to understand as this modern era of Mappo can transmit. With the access to our great scholars in both Buddhist lineage as well as those academically trained, this wealth of information can be overwhelming. It is my task to reduce the noise or extraneous pursuits of politicized agendas to deliver a paired back but no simplified, straightforward teaching without distraction. The sciences today, from physics and cosmology to psychology and neurology, provide a glut of observable truths that apply directly to our Buddhist practices and rhetoric. I provide here a direct transcription of video talks from the Internet with interruptions of personal insight regarding Buddhist teachings and practice, as a guide to interrelate our practice with the provided text.

*Sifu, Bodhisattva Sylvain Chamberlain*

*Love and respect,*

*NaMuMyoHoRenGeKyo*

## **Transcript Annotated**

*(I find the following text is more easily absorbed while starting and repeating the occasional deep slow breath.)*

Consider the most ordinary object you can find. A copper wire. A strip of metal so commonplace you have probably walked past thousands of them today without a second thought. Inside that wire pressed tightly into the rigid atomic lattice are electrons. Not dozens, not millions. We are speaking of numbers that collapse the human imagination entirely. A single gram of copper contains roughly 600 billion trillion electrons. Each one spinning, each one carrying a precise negative charge.

Each one responding to electromagnetic fields with a behavior so uniform, so absolutely consistent that no measurement ever performed in the history of physics

has found even the faintest deviation between one electron and another. That uniformity is not a coincidence. It is not the result of a highly efficient cosmic assembly line producing particles to a tight manufacturing tolerance. It is something far stranger, far more geometrically radical. The uniformity of every electron in the observable universe may be pointing directly at a physical truth so disorienting that it restructures not just our picture of matter but our picture of time itself. The truth whispered by the mathematics is this.

There may not be countless electrons. There may be precisely one. To understand why a serious physicist would make that claim, we need to first appreciate what it genuinely means for two particles to be indistinguishable.

In the classical world you inhabit, no two objects are perfectly identical. Two billiard balls of the same color will differ in microscopic surface scratches. Two water droplets will vary in their molecular count.

Identity in the classical world is always approximate, but in the quantum world, identity is absolute.

- Every electron in the universe carries a charge of  $1.602 \times 10^{-19}$  C.
- Every electron carries a rest mass of  $9.109 \times 10^{-31}$  kilograms.
- Every electron carries a spin of  $\frac{1}{2}$ .

These numbers do not vary by one part per billion. They do not vary by one part per trillion. They are not similar. They are to the full precision of every instrument ever constructed perfectly identical. Physicists call this quantum in-distinguish-ability and within the formalism of quantum mechanics. This is not merely a descriptive observation. It is a structural axiom of the theory. When you write down the mathematical wave function for a system of two electrons, the laws of quantum mechanics demand that you cannot label one as electron A and the other as electron B in any physically meaningful way. If you swap them, the wave function changes sign, a property called anti-symmetry. But the observable physics remains completely unchanged. The electrons have no hidden serial numbers. They carry no individual identity markers. They are at the deepest mathematical level. The theory can reach one in the same kind of thing.

Most physicists absorb this fact, note its strangeness, and move on. But in the 1940s, a young physicist named **Richard Feynman** received a phone call from his mentor, **John Archibald Wheeler**. Wheeler had been thinking about this in-distinguish-ability in a way that did not merely accept it, but demanded an explanation for it. Wheeler posed a question that cut straight to the foundation.

What if the reason every electron is perfectly identical is not because there are many particles manufactured to the same specification?

What if the reason is that there is only one electron, one single particle, and it is the same particle appearing over and over across space because it is moving back and

forth across time. To feel the full geometric weight of that idea, you need a particular image.

Picture a single long shoelace lying on a table.

But this is no neatly coiled shoelace. It has been dropped, tangled, folded, knotted, and twisted back over itself thousands of times. The lace runs left, doubles back, crosses itself, loops forward, reverses again in a wildly complicated three-dimensional knot that piles up across the surface of the table.

Now, take a flat, rigid plane, a mathematically perfect two-dimensional surface, and slide it horizontally through the middle of that knot. You are not cutting the lace. You are simply observing the cross sections where the lace passes through your flat plane. When you look at that flat surface, what do you see? You do not see one continuous string. You see dozens, perhaps hundreds of isolated dots scattered across the surface. Each dot is a separate cross-section of the same single lace. Each dot appears completely independent. Each dot, if you were a creature confined to that flat plane with no awareness of the third dimension above or below you, would look like a distinct and separate object with no connection to any other dot. The universe operates in this precise geometric manner. According to Wheeler, the flat two-dimensional slice is your localized experience of the present moment, a thin cross-section through the four-dimensional geometry of spacetime.

The single shoelace is the world line of one solitary electron, a continuous four-dimensional path drawn through spacetime from the earliest moments of the universe to its furthest thermodynamic future. And just as the lace doubles back on itself in three dimensions, this single electron doubles back in time, moving forward through the temporal dimension, then turning around and moving backward, then forward again, weaving its world line through the fabric of spacetime in an incomprehensibly dense and frantic pattern. Every time that world line passes through your present moment while moving forward in time, you observe it as an electron, a negatively charged particle sitting at that location in space. But here is where the physics becomes startling. Every time that same world line passes through your present moment while moving backward in time, you observe something different.

You observe a positron, the antimatter equivalent of the electron.

A particle with precisely the same mass, the same spin, the same magnitude of charge, but with the charge reversed from negative to positive. This is not speculation. The mathematics of **Paul Dirac** made this prediction before the positron was even discovered. When Dirac wrote down his relativistic equation for the electron in 1928, the mathematics was unambiguous. The equation required two solutions. One described a particle with negative charge moving forward in time. The other described the same particle with positive charge moving backward in time. Dirac initially hesitated, wondering if the second solution described the proton, but the mathematics would not cooperate. The mass was identical to the electron. In 1932, **Carl Anderson** found the positron in a cloud chamber. The mathematics had been right. A particle moving backward through time appears from the perspective of

an observer moving forward through time as an anti-particle. This is the insight that Wheeler was handing to Feynman. When you look at a positron, you are not looking at a different kind of particle. You are looking at the same electron, the same point of matter with the same world line simply traversing the time dimension in the opposite direction as it passes through your present moment. The shoelace has doubled back. The cross-section of the forward-moving lace looks like one thing. The cross-section of the backward moving lace looks like something else. But they are geometrically, mathematically, physically the same lace.

Now consider what happens when an electron and a positron meet and annihilate. Two particles collide and in their collision they produce a burst of gamma-ray photons. The electron and positron vanish. This event in the standard picture looks like mutual destruction. Two particles of matter and antimatter eliminating each other. But in the Wheeler picture, annihilation is something geometrically different. It is the moment when the single world line of that one electron turns around in time. The forward-moving electron reaches a specific point in spacetime and at that point the world line bends. It reverses its temporal direction. What looks like a collision between two separate particles is from the four-dimensional perspective simply the turning point of one continuous path. The electron arrives, folds back through time, and we observe the fold as an annihilation event. Similarly, "pair" production the process by which a high energy photon spontaneously generates an electron and a positron from apparently empty space is not the creation of new matter from nothing. It is the other type of turning point. It is the moment the world line reverses again from backward moving to forward moving. The positron traveling backward through time, toward this moment and the electron now moving forward away from it, are the same particle executing a temporal turn. Energy is conserved.

The photon provides the energy equivalent of the mass of the pair. The geometry of spacetime accommodates the turn. The profound strangeness of this picture is not just philosophical. It has quantitative implications. If Wheeler is right, then the number of electrons and the number of positrons in the observable universe must be perfectly equal. Every forward moving segment of the world line contributes one electron to the present moment. Every backward moving segment contributes one positron. If the world line is one continuous path that begins at the start of time and ends at the end of time with no external beginnings or endings, the count must balance. And here the picture encounters one of its most honest difficulties. The observable universe does not appear to contain equal numbers of electrons and positrons. It appears to contain vastly more electrons than positrons. This is actually one of the deepest unsolved problems in physics. The matter / antimatter asymmetry problem. Wheeler acknowledged this tension directly. The one electron universe in its pure form requires a balance that we do not observe. Physicists have proposed that much of the antimatter is hidden, that the world line spends much of its time outside the observable region of the universe, that the turns happen at the extreme temporal boundaries beyond our cosmic horizon. But even setting aside the asymmetry problem, the conceptual framework that Wheeler and Feynman were pointing toward has roots that extend far deeper than this single hypothesis.

The mathematical tools Feynman developed in response to Wheeler, the Feynman diagrams, the path integral formulation of quantum mechanics. These are now the foundational language of quantum field theory. And in that language, the treatment of antiparticles as particles moving backward through time is not just a philosophical interpretation. It is a standard mathematical technique. The propagator for an antiparticle in quantum field theory is by routine mathematical convention a particle propagating backward through the time coordinate. This is not metaphor. It is how the calculations are done. The charge conjugation symmetry the mathematical operation that turns a particle into its antiparticle combined with the time reversal operation produces a transformation that leaves the fundamental equations of physics unchanged. **CPT** symmetry (*Charge, Parity, and Time reversal symmetry is a fundamental symmetry of physical laws under the simultaneous transformations of charge conjugation, parity transformation, and time reversal.*), the combined in-variance under charge conjugation, parity inversion, and time reversal, is one of the most rigorously tested symmetries in all of physics. Its validity is supported by every experiment ever conducted. And its existence is precisely what you would expect if antimatter is matter moving in reverse time. The mathematics of nature is built to accommodate this picture.

Now, return to that copper wire. return to those 600 billion trillion electrons. Wheeler is suggesting that every single one of those electrons is the same point of matter, the same mathematical object, a single charged point of energy that has been weaving its world line through the four dimensions of spacetime since before atoms existed, passing through your present moment in so many different locations that it gives the impression of being a vast, uncountable multitude.

You are not surrounded by countless different things. You are surrounded by one thing appearing at countless locations because time is not a simple linear river flowing in one direction. It is a geometric dimension and a single particle can thread itself through that dimension in patterns of staggering complexity. The electron you detect in the lowest orbital of a hydrogen atom in a star 60,000 light-years away is not a different object from the electron in the nerve fiber carrying signals through your visual cortex. Right now they are on this picture the same point of matter at different positions on the same four-dimensional world line. The apparent separation between them is a separation in three-dimensional space.

But their world line is one, their identity is one. There is a particular kind of vertigo that accompanies this realization. Not the vertigo of confusion, but the vertigo of seeing something true and measuring how far it reaches. The material universe with its staggering multiplicity of particles and structures and complexities may be the temporal shadow of a single restless point. The fabric of matter as we experience it may be woven from one thread doubled back on itself with such frantic geometric density that it creates the appearance of a vast independent multiplicity. The shoelace is one. The dots on the flat surface of your present moment are many. The difference between those two statements is not a difference in the physical object. It is a difference in the dimension available to your perception.

Expand your awareness to include the full geometry of time and the multiplicity dissolves. Contract your awareness to the thin slice of the present and the one

becomes countless. This is what the mathematics is telling us. Not as mysticism, not as poetic license, but as the rigorous geometric consequence of taking temporal symmetry seriously, of following the Dirac equation to its logical conclusion, of asking what perfect quantum in-distinguish-ability actually demands as a physical explanation. The universe did not manufacture an enormous inventory of identical particles. The universe has one particle and that particle has spent the entire history of time and perhaps the entire future of time filling every corner of physical reality with the evidence of its single relentless journey. A!

*(Consider the language of Buddhism. Cycle of Birth and Death; Duality, Delusion, moment-to-moment; and on it goes. The rhetoric of capturing this Engine of life in process, to witness its frenetic momentum in total without adherence to momentary snapshots. Perceiving the whole of its drama while carried in its timeless time. Could this be a description of Buddhahood? Could visualizing the multitude of "shoelaces" of the material world lead to a removal of the "self" to observe the entire tapestry outside and through one's mind, one's "being"?)*