Transforming an Electron into a Positron: A New Paradigm for Physics

Mark David A. Rosen
General Applied Physics *Solutions*, Delanco NJ 08075, USA
mdarosen@post.harvard.edu

Since the discovery of the positive electron (positron) in 1932, physics has ignored the more plausible possibility that charge is not a fixed property of subatomic particles. Instead of looking for the conditions under which this property might be altered, it has become dogma that the same particle with different charge states are distinct entities solely based on the negative energy solutions of the Dirac equation (formulated in 1928)[1] with its strange negative energy sea of electrons construct (with "holes") in 1930) [2]. It is about time to consider the alternate more logical interpretation – that under certain conditions, an electron can be transformed into a positron. Recent experimental evidence of heat transport along a quantum Hall edge seems to support the formation of a positively charged entity (positron) that can conduct heat in the opposite direction to negative electron flow.[3] A relatively simple experimental test for verifying this new electron behavior is presented in the hope of advancing this line of research.

INTRODUCTION

Lee Smolin in his book "The Trouble with Physics" points out the quandary in which physics finds itself:

"The story I will tell could be read by some as a tragedy. To put it bluntly—and to give away the punch line—we have failed. We inherited a science, physics, that had been progressing so fast for so long that it was often taken as the model for how other kinds of science should be done. For more than two centuries, until the present period, our understanding of the laws of nature expanded rapidly. But today, despite our best efforts, what we know for certain about these laws is no more than what we knew back in the 1970s. How unusual is it for three decades to pass without major progress in fundamental physics? Even if we look back more than two hundred years, to a time when science was the concern mostly of wealthy amateurs, it is unprecedented. Since at least the late eighteenth century, significant progress has been made on crucial questions every quarter century."[4]

Usually a situation like this indicates a mistake may have been made in the past – **that some basic physical assumption may be wrong**.

One possibility may be the idea that the sign of electric charge ("-") is a fixed property of the electron (and other sub-atomic particles). We have been extremely successful at using and manipulating the electron – it is the technological foundation of our civilization.[5][6][7][8][9] The electron may have one more property for us to exploit. A re-interpretation of the discovery of the positive electron ("positron") could indicate that the charge state of the electron can be manipulated as well (i.e., transforming an electron into a positron) – something that could have an extraordinary impact on physics and profound implications for present day problems.[10] [11]

HISTORY OF THE NEGATIVELY AND POSITIVELY CHARGED ELECTRON

The electron was discovered in 1897 by J. J. Thompson.[12][13] He determined that it was a negatively charged particle and calculated its mass to charge ratio. The charge was measured by R. A. Millikan in 1909 using oil drops in the electric field between two parallel plates.[14] In 1932, a positively charged electron (positron) was discovered by C. Anderson in the high energy collisions of cosmic rays recorded in cloud chamber photographs.[15] There are two possible ways of interpreting this positive electron. Either it is a separate distinct entity or it is an alternate charge state of the electron implying that the charge (sign) of the electron can be changed. It seems the latter was never really considered because of the previous theoretical work of P.A.M. Dirac (1928) [1]. He developed an equation describing the electron's behavior incorporating relativistic effects. Instead of discounting the negative energy solutions for this equation, an interpretation that eventually morphed into a positive electron was proposed. The subsequent discovery of the positive electron supposedly corroborated the theory and the interpretation was set – the positive electron has been a distinct, separate entity ever since (the birth of the "antiparticle"). Interestingly, Dirac wrote in his 1928 paper [1][p. 612]:

"One cannot do this on the quantum theory, since in general a perturbation will cause transitions from states with W positive to states with W negative. Such a transition would appear experimentally as the electron suddenly changing its charge from –e to e, a phenomenon which has not been observed." [W = energy][1]

Halpern and Thirring in their quantum mechanics book

[1] Just because it had "not been observed" does not mean it could not happen under certain circumstances. The discovery of the positive electron in 1932 was not initially universally accepted.[16]

(1931) also noted:

"Dirac's system of equations refers to particles of charge +e as well as to those of charge –e; … this signifies that according to Dirac's theory the electrons can change their sign. …" (they felt the negative solutions should be ignored until the problems with them can be resolved) [16][p. 150]-- the only statement found that is close to what is claimed in this paper.[2]

It seems more logical to treat the discovery of a positive electron as indicating that the sign of electric charge is not a fixed property. It was unfortunate that this discovery appeared to justify the Dirac equation's negative energy solutions with their strange interpretation (infinite negative energy sea of electrons) – this has misled physics ever since.

EVIDENCE FOR TRANSFORMING AN ELECTRON INTO A POSITRON (e^- + strong B (or E)→ e^+)

Since its discovery in 1982, the Fractional Quantum Hall Effect (FQHE) has given birth to the concept of "fractionally" charged "quasiparticles" or "composite fermions". [17][18][19] This phenomenon involving a two dimensional electron system (2DES) occurs at extremely low temperatures in the presence of a strong perpendicular magnetic field. A simpler approach than fractionally charged quasiparticles (or composite fermions) might be to actually assume that the charge state of a fraction of the electrons present has actually been changed (i.e., the net negative charge has been reduced). This would be consistent with the experimental facts. Recent experimental work at Harvard measuring the heat flow under conditions necessary for the FQHE may be the first real evidence supporting the idea that positive electrons (positrons) are being formed.[3]

What was discovered at Harvard was that under conditions necessary for the FQHE, heat is not only transported downstream with the electron flow but upstream as well. Based on the fact that no charge is seen to be transported upstream, "Neutral Modes" have been invoked as a scheme to explain this unexpected heat transport upstream.[3][20][21][22] A much simpler and more logical explanation is that, under the given experimental conditions, electrons are being transformed into positrons. Just like electrons carry the downstream heat, positrons would carry it upstream. No charge transport would be measured upstream since a positron would annihilate with an electron before any detection were possible. This simple idea explains everything without resorting to complex theoretical constructs. An easy test to see if this is happening is to look for the gamma ray signature of electron-positron annihilation. The formation of positrons would also resolve the "unknown microscopic origin" of the FQHE.

If the charge state of the electron can be manipulated, then the next obvious question concerns determining the conditions under which it can be changed.

PROPOSED CONDITIONS FOR e^- + strong B (or E)→ e^+ TO TAKE PLACE

Based mainly on the heat transport work and the FQHE, the possible conditions needed to alter the charge state (sign) of a low (kinetic) energy electron can be stated as:

- **Have either a one or two dimensional electron system (1 or 2 DES)**. Although the FQHE is at extremely low temperatures, it is felt that this transformation can occur at room temperature or higher (refer to discussion below in Excess Heat Produced in Electrochemical Cells).-- (this would still be a situation of relatively low electron kinetic energy)

- **Apply a strong magnetic (or electric) field** (of sufficient strength to cause the charge state to change).
At the extremely low temperatures associated with the FQHE (low kinetic energies of the electron), strong external magnetic fields may be sufficient to cause the charge state of the electron to flip. It is felt that very strong electric fields are both easier to produce and effective in transforming an electron into a positron at much higher temperatures. This is based on the two phenomena discussed below.

OTHER POSSIBLE PHENOMENA RELATED TO e^- + strong E or B→ e^+

Over the last 30 years new phenomena have been observed that might be correlated with such an effect. Two possibilities are

1. **High Temperature (High T_c) Superconductivity** – High T_c materials have a layered planar structure. This implies a situation for a 2DES – a potential necessary condition for changing the charge state of the electron. The electric field strength in these layers would be high, but obviously not uniform. The electron could find itself "flipping" back and forth between negative and positive states as it moved within the layer. This might be a

[2] Conservation of Charge is a fundamental guiding principle in physics. Physicists have been looking at the theoretical consequences if it were not conserved as well as searching for charge violating decay schemes [28] [29] If the transformation of an electron into a positron requires an external applied electric or magnetic field, then the process does not violate this concept (refer to section on hypothesized conditions for changing the charge state).

sufficient condition by itself to allow lossless charge transport without needing pairing (or it could possibly be a mechanism for pairing, if needed, as in the BCS theory and current ideas about High T_c materials [23]). Pressure would obviously alter the electric field between the layers and give rise to changes in the critical temperature T_c. that have been observed.

There is no theory at present to explain High Tc Superconductivity.[24] If the charge state of the electron can be changed, this presents a new property of the electron that could help to understand the superconductivity in these materials.

2. **Excess Heat Produced in Electrochemical Cells –** The electrochemical production of excess energy has been firmly established by many groups active in this area**.**[25][26] The question is "what is the mechanism?" An important clue to this mystery comes from the fact that a prolonged incubation period (possibly 100's of hours) is seen before excess heat is produced. During this period, electrochemical deposition can alter the morphology of the electrode surface causing a 3-dimensional nano-texture, the perfect geometry for creating a 1 or 2 DES.[27] This is one of the two proposed requirements needed to flip the charge state of the electron. The other is a very strong magnetic or electric field. In this case, a very strong electric field would be produced between the cations in solution and the electrons in the anode (at least 10^9 N/C, based on the two charged species being separated by about 10 Å). If positrons are subsequently created, then the energy producing mechanism would be electron-positron annihilation.

   This is especially important. Transforming an electron into a positron at room temperature is critical to practical applications of this concept.

EXPERIMENTAL VERIFICATION

It is relatively easy to experimentally verify whether electrons are being transformed into positrons in any of the above physical processes. The annihilation reaction of the electron and positron creates a unique gamma-ray signature of either 2 photons around .511 MeV (180 degrees apart -- normally what would be expected) or 1 photon twice that in energy. Placing gamma ray detectors around the sample to detect this radiation signature would be needed (the intensity in most cases would be very low). Sufficient shielding to eliminate the background radiation is critical.

If the presence of positrons is confirmed, then experiments are needed to delineate the precise physical and external applied (electric) field conditions needed to cause this transformation.

CONCLUSION

While new physics phenomena continue to be discovered, our ability to explain them lags far behind. Usually the underlying reason for such a situation is that there may be something wrong with some past fundamental assumption(s). Mainstream physics seems to be "thriving" on complexity and extremely speculative ideas that are in stark contrast to the simplicity that has marked past progress and understanding. A simple experimental fact is that the electron exists in at least two charge states, negative and positive (there is a good chance that there is also a neutral electron – anyone thinking neutrino?[3]). But because of a mathematical equation with a really strange interpretation invented to explain its negative energy solutions, physics failed to consider whether the electron's charge state could be manipulated – a very simple plausible idea. To an experimentalist, math is just a tool like anything else in the lab to give understanding and insight into our physical world. The discovery of the positive electron was unfortunately a serendipitous and misleading "confirmation" of a theoretical assumption that does not make a lot of sense (Dirac's infinite negative energy sea of electrons construct).

If the electron can be transformed into a positron, the consequences are incredibly profound. For one, it simplifies particle physics. It would imply that the preferred state is normal matter, with antimatter (really antiparticles) being just another state of normal matter. The "mystery" of why we exist (i.e., the imbalance between matter and antimatter) is solved. Having another property of the electron to exploit also gives us an additional tool in which to possibly understand things like high temperature superconductivity – but this is just the beginning. Being able to easily and cheaply (hopefully) create positrons for annihilation is a potential solution to our critical energy needs as well as a boon to the economy. It also would be the solution to many other critical problems (would not need an electrical grid or nuclear power plants [stops nuclear proliferation]; replaces the battery; makes desalination feasible; changes foreign policy, etc.).[10]

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