

# The electric vocabulary

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## Abstract

Since the 1600s, the developments in the understanding of electrical phenomena have frequently altered the models and metaphors used by physicists to describe and explain their experiments. However, to this day, certain relics of past theories still drench the vocabulary of the subject, serving as distracting fog for future students. This article attempts, through historical illumination, to shine through the mist of electrostatic terminology and offer a clearer view of the classical model of electricity.

## Thales (624BC–546BC)

The Greek philosopher Thales is documented as being one of the first to observe that a piece of amber, when rubbed with fur, would pick up small pieces of straw<sup>1</sup>. This seems to have been amber's defining characteristic for many centuries. For example, the Arabic word for amber, 'كهرمان', (pronounced kah-roba) means 'straw robber'. One Ancient Greek word for amber was 'harpax' meaning 'robber' [2].

However, from Homer's 'Odyssey', and some other sources, we know that the Greeks also called amber, 'ήλεκτρον' (elektron). This derives from the word 'elektor' meaning 'sun's glare', in reference to amber's shiny surface [3]. Obviously, it is this word for amber that has carried into our modern vocabulary as 'electron'.

As well as amber's ability to attract straw, Thales also knew that 'lodestone', a type of rock, attracted iron nails. Thales was very interested in these two tricks of nature. He likened the power that these objects had over other items (such as nails and straw) to the power humans and gods have to move and shape their world. This led him to a bold idea concerning lodestone and amber that he applied to the whole cosmos. Aristotle and Diogenes Laërtius write:

*'Thales, too, to judge from the anecdotes related of him, conceived soul as the cause of motion, if it be true that he affirmed the lodestone to possess soul, because it attracts iron' [4].*

*'...Aristotle and Hippias say that he attributed souls also to lifeless things, forming his conjecture from the nature of the magnet, and of amber' [5].*

Thales' 'explanation', by present standards, is underwhelming. The agency he proposes to explain the abilities of amber and lodestone (the property of having a soul) lacks any quantitative description, or prediction of additional phenomena. There is no experiment that could be set up to test whether Thales was incorrect, at least none we know of. Thus, his theory is not falsifiable and therefore is not one of modern science [6]. Nevertheless, this was the very first step of the human investigation into the behaviour of these two intriguing objects.

## William Gilbert (1544–1603) and Sir Thomas Browne (1605–82)

Nature had to wait around 2200 years before any further investigation was made into amber or lodestone. In 1600, the English physicist

<sup>1</sup> Very little is known of Thales. For a brief account, see [1].

William Gilbert, wrote a book called 'De Magnete' ('On Lodestone'), considered to be one of the first modern scientific works. He was devoted to utilizing experiments as a way of finding out about the world, and this is why he was able to discover so many new things.

The book, as the title suggests, is mostly concerned with lodestone. Gilbert observed that a piece of iron could behave like lodestone when the two were rubbed together. He found that there were two sides to a piece of lodestone which sometimes attracted other lodestones, and sometimes repelled, depending on which way around the two were held. Other investigations showed that a compass needle on a sphere of lodestone seemed to mimic where the needle points on the surface of our spherical Earth. Was the Earth a large ball of this special metal, Gilbert wondered<sup>2</sup>.

In addition to lodestone, Gilbert devotes a small section of the work to amber [8]. He lists a great many substances that are amber-like in their attractive properties and names them 'Electricks, things which attract in the same manner as amber' [9]. He also lists materials, other than straw, which are attracted towards electriks. In Gilbert's original Latin text, he calls the electriks 'electricita coporea' (electric bodies) [10]. This was later anglicized to 'electricity' by Sir Thomas Browne in 1646.<sup>3</sup> Browne writes:

*'Again, The concretion of Ice will not endure a dry attrition without liquation; for if it be rubbed long with a cloth, it melteth. But Crystal will calefie unto*

<sup>2</sup> The original work ([7]) is a little verbose by modern standards. For a more condensed description of Gilbert's findings read [12].

<sup>3</sup> Unfortunately, many textbooks, teachers and students use 'electricity' as a thick brushstroke term to be applied to all manner of electrical phenomena. Current, charge, potential difference, electrical power each all seem, to someone, to be 'electricity'. However, Gilbert and Browne were thinking in more simple terms. Less was known about electrical phenomena in their time. 'Electrics' referred to amber-like objects and 'electricity' was the property they exhibited. Similarly, we have 'elastic' objects that have the property of 'elasticity'. 'Electricity', in our time of greater understanding, is a word to describe a larger process. Just as 'evolution' as described by Darwin never names an item of the process as 'evolution', we do not call any aspect of electrical phenomena 'electricity'. Electricity is nothing but the name of the textbook. That this word is misused by a great majority suggests that the electric vocabulary is widely misunderstood.

*electricity; that is, a power to attract straws and light bodies, and convert the needle freely placed'* [11].

Gilbert was also the first person to draw a clear distinction between electrik (amber) and magnetik<sup>4</sup> (lodestone) phenomena, which had been paired since Thales as similarly mystical objects. He does this in several ways. Firstly, he notes that amber requires rubbing by friction to reveal its hidden attractive abilities whereas lodestone does not. Also, the attraction of an electrik seems to depend upon the heat and moisture content of the surrounding air. This was not the case for magnetiks, which would still attract and repel under water [12].

### Charles Du Fay (1698–1739) and Jean-Antoine Nollet (1700–70)

Charles Du Fay was a French physicist who, in 1736, greatly developed the understanding of electriks. Inspired by Stephen Grey's experiments at England's Royal Society, which he had studied in detail, Du Fay carried out a large number of his own experiments with different substances [13]. In addition to the electrik substances named by Gilbert, Du Fay was able, with a combination of heating and rubbing, to turn almost all substances (except for metals and fluids) into electriks.

Moreover, he noticed that these objects sometimes repelled as well as attracted and attempted to describe this previously unnoticed phenomena.

*'...if [a body] attracts [an electrified silk thread], 'tis certainly of that kind of Electricity which I call vitreous; if on the contrary it repels, 'tis of the same kind of Electricity as Silk, that is, of resinous'* [14].

So, Du Fay added a further distinction; not only could objects become 'electrik' (amber-like), but he found two categories. Objects that repel electrified glass he named 'vitreous' (from the

<sup>4</sup> The word 'magnetism' comes from the mythical story of the discovery of lodestone. A man (some claim called 'Magnes') was shepharding in an area of Greece called Magnesia around 2000BC when he found that the nails in his sandals and the bottom of his staff stuck to the rock. This type of rock was later named lodestone. More generally, this type of thing, a 'magnet', is named from the Greek 'magnítis líthos' (μαγνήτης λίθος), which means 'Magnesian stone'.

Latin, ‘vitrium’, for glass–glass-like)<sup>5</sup>. Objects that repel electrified resin he named ‘resinous’ (to mean ‘from resin’–resin-like)<sup>6</sup>.

In 1746, Du Fay’s student Jean-Antoine Nollet tried not only to describe the new phenomena, but to also explain it. After working as his assistant from 1731–2, Nollet was aware of Du Fay’s later work through a maintained correspondence <sup>7</sup>.

In stark distinction to Thales, Nollet needed some machinery in scientific theories for him to consider them truly explanatory.

*‘Mechanical explanations are the only ones capable of advancing experimental physics’<sup>8</sup>.*

He had the idea that the currents of two fluids could explain the attraction and repulsion of electriks. He thought that, since one elektrik can simultaneously attract and repel several others, there needed to be two types of process to explain the two types of interaction. (It is unclear from Nollet’s work whether he means two distinct fluids or two states of the same fluid.) His two fluids were described as ‘effluent’, from the Latin ‘effluere’ meaning ‘to flow out’; and ‘affluent’, from the Latin ‘affluere’ meaning ‘to flow in’. This flowing in and out of electriks provided a mechanism that not only described, but explained all experimental results obtained so far <sup>9</sup>.

The fluid metaphor was one of several of the period. It remains in our vocabulary with ‘electrical current’, the flow of an electrical fluid. Some contemporaries of Nollet also had two-fluid theories of electriks, the most notable of these was the work of Francis Hauksbee, whom Du Fay cited as an influence<sup>10</sup>.

<sup>5</sup> Incidentally, the root of this word is also used in naming ‘vitreous humour’; the clear glass-like liquid behind the lens of the eye, and ‘vitrification’; the process of trapping radioactive material in glass for storage.

<sup>6</sup> We now know these two groups of objects are on opposite sides of the triboelectric series. One set (resinous) gains electrons while the other (vitreous) loses electrons, to varying degrees. The explanation for this occurrence requires some complex knowledge of the chemical composition and potentials of the electron shells of the materials. This, amongst other things, is the study of a branch of chemistry called electrochemistry.

<sup>7</sup> A translation from the French in [15].

<sup>8</sup> Translation from the French, in [16, p 284].

<sup>9</sup> For Nollet’s original French text, see [17] For a condensed English description, see [17].

<sup>10</sup> Francis Hauksbee’s two-flux theory.

Nollet’s need for a mechanism to explain the world, by means of contact forces between objects, had been the prevailing opinion of physicists since the work of Descartes [18]<sup>11</sup>. The absence of this kind of theory in the work of Benjamin Franklin, our next contributor to the electric vocabulary, was disturbing to Nollet. He writes that Franklin’s inability to explain electrostatic attraction and repulsion, but only describe it ‘...is almost like saying to a man who points to a weathervane as proof of the wind: Ho! we don’t know what turns the vane’ (see footnote 8).

### Benjamin Franklin (1706–90)

*‘Bright Amber shines on his electric throne,*

*And adds ethereal lustres to his own.*

*Led by the phosphor-light, with daring tread,*

*Immortal Franklin sought the fiery bed;*

*Where, nursed in night, incumbent  
Tempest shrouds,*

*The seeds of Thunder in circumfluent  
clouds,*

*Besieged with iron points his airy cell,*

*And pierced the monster slumbering in  
the shell.’*

Erasmus Darwin (Charles Darwin’s grandfather), from his poem ‘The Economy of Vegetation’ [19].

Benjamin Franklin invented a description of electrical experiments that only required one fluid (or as he preferred to say ‘the electric fire’, although he used both terms<sup>12</sup>) compared to Nollet’s two fluids. This simpler model, supported

<sup>11</sup> ‘If you find it strange that I make no use of the qualities one calls heat, cold, moistness, and dryness, . . . , as the philosophers [of the schools] do, I tell you that these qualities appear to me to be in need of explanation, and if I am not mistaken, not only these four qualities, but also all the others, and even all of the forms of inanimate bodies can be explained without having to assume anything else for this in their matter but motion, size, shape, and the arrangement of their parts.’ Nollet most likely read this passage from Descartes’ original ‘Le Monde’ published in full in 1677.

<sup>12</sup> For example, his letter to Collinson of September 1753 only talks about the ‘electric fluid’ and not the ‘electric fire. Found in [20].

by the very useful results he obtained with his lightning rod, gradually persuaded the scientific community to dismiss any ‘two-flux’ (two-fluid, two-fire, or otherwise) explanation in favour of his ‘single-flux’ alternative.

In a series of letters to his English friend Peter Collinson<sup>13</sup>, Franklin communicated his developing thoughts on the subject. The process necessitated the formulation of a new vocabulary to describe his ideas, much of which we still retain today.

*‘I feel a Want of Terms here and doubt much whether I shall be able to make this intelligible’* [22].

In Franklin’s time, people knew how to make devices, such as Leyden Jars that could be electrified to such an extent they were able to create substantial sparks. The effect was significant enough to draw attention to its similarity with lightning. As experiments of this kind became more numerous, the process of electrification acquired a new verb:

*‘When we use the term charging and discharging the phial, it is in compliance with custom, and for want of others more suitable’* [23].

The ‘custom’ to which Franklin referred is likely to be derived from his familiarity with the vocabulary of weaponry.

The charging of a cannon, or gun, in Franklin’s time was a spectacle similar to the rubbing of an object required for electrification, the process we call ‘electrostatic charging’. As with guns, you could charge an electric and then discharge it. Franklin and his contemporaries were also fond of using Leyden Jars as weapons of mischief, discharging them by sending sparks to their friends’ bodies. Occasionally, the playful game terminated in a discovery of a sense of scale for a lethal quantity of electric discharge.

Franklin also thought to connect Leyden jars together. Here he describes a procedure with similar devices:

*‘Upon this we made what we called an electrical battery, consisting of eleven panes of large sash-glass, armed with*

*thin leaden plates, pasted on each side, placed vertically, and supported at two inches distance on silk cords, with thick hooks of leaden wire, one from each side, standing upright, distant from each other, and convenient communications of wire and chain, from the giving side of one pane, to the receiving side of the other; that so the whole might be charged together, and with the same labor as one single pane (. . .)’* [24].

A ‘battery’ of electrical storage devices could be lined up side by side and discharged simultaneously, just like a battery of cannons on a ship, which is the likely origin of Franklin’s terminology.

Guns were also said to possess charge, and this became part of the electric vocabulary as well, where ‘charge’ gradually replaced ‘electrical fire’. The history of the development of words as they change from one syntactic category to another (in our example ‘charge’ moves from verb to noun) is a topic too large for this article, yet these considerations are also important for the development of the electric vocabulary<sup>14</sup>.

Concerning the electrical fire, Franklin offers the following model:

*‘We suppose, as aforesaid, that electrical fire is a common element of which every one (. . .) has his equal share, before any operation is begun with the tube. A, who stands on the wax and rubs the tube, collects the electrical fire from himself into the glass and his communication from the common stock being cut off by the wax, his body is not again immediately supplied. B, (who stands on the wax likewise) passing his knuckle along near the tube, receives the fire which was collected by the glass from A; and his communication from the common stock being likewise cut off, he retains the additional quantity received. (. . .) If they touch while electrizing, the equality is never destroyed, the fire only circulating. Hence have arisen some new items among us. We say B (and other Bodies alike circumstanced)*

<sup>13</sup> For a full list of Franklin’s electrical correspondence, see [21].

<sup>14</sup> A detailed account of the movement of the word ‘electric’ from noun to verb can be found in [10].

*are electricised positively; A negatively; Or rather B is electricised plus and A minus* [25].

Note that Franklin is saying that charging does not *create* the electric fire, but simply redistributes the electric fire that resides in electric objects. The essence of Franklin's idea endures to the present day as 'the conservation of charge'.

As Franklin writes, if an object had the usual amount of this electrical fire, it was said to be 'neutral'. If it was in excess, it was said to be 'positive', and an object lacking in the electrical fire was said to be 'negative'. When two objects touched, the electrical fire moved from objects that were positive to those that were negative, restoring the balance. It is easy to see how a combination of these considerations and the vocabulary so far mentioned leads to phrases such as '*B* was charge positively', or '*B* has a positive charge'.

To describe Du Fay's model with Franklin's terms: vitreous materials are those that gain a positive charge (a net increase of electrical fire), and resinous materials are negatively charged. This can be determined by studying Franklin's description of his experiment above. In it, the glass tube (a vitreous material) collected the electrical fire when charging, and hence is positively charged.

Notice that Nollet was quite correct about the lack of a mechanistic explanation in Franklin's model. The electrical fire, although able to describe *when* objects attract and repel, cannot explain *why* they do so. Similarly, Newtonian gravitation lacked explanation (as Newton was well aware) and only describes the variables upon which force of gravitation depends. The theory does not explain *how* it is possible that the sun exerts a force upon the planets without touching them. He didn't know what the machinery was. It was not until Einstein's theory of general relativity of 1916 that gravity could be explained as the curvature of spacetime (caused by the sun's mass) distorting the path of the planet.

Quantum phenomena, contrastingly, appear to elude any causal, mechanistic 'explanations'. Detailed predictive descriptions are the best—and only—theories to date. For example, radioactive decay seems to have no internal machinery that determines exactly when an atom will decay, and it is therefore supposed that the world has a peculiar intrinsic randomness. Unknown to both Nollet

and Franklin, modern experimental results seem to necessitate our abandonment of Nollet's criterion for a physical theory. Nollet was right about Franklin, but wrong about physics.

### Michael Faraday (1791–1867) and William Whewell (1794–1866)

In 1834, the English physicist Michael Faraday started to publish articles on 'electrical decomposition'. His experiments combining chemical and electrical apparatus aimed to investigate the procedure of separating compounds using batteries.

Faraday was not the first to achieve this. His mentor, Sir Humphry Davy, discovered six new elements using this method in 1807<sup>15</sup>. Prior to Davy, Anthony Carlisle and William Nicholson discovered the process of electrical decomposition by separating water into hydrogen and oxygen [27]. Independently, a few months later, Johann Ritter made the same discovery, with the addition of collecting and measuring the two gases. However, Faraday was the first to conduct a full quantitative investigation, and to attempt an electrical explanation of this process.

His description of electrical decomposition required a large number of distinctions to be made, which necessitated an expansion in vocabulary. After consultation with his friends Whitlock Nicholl and William Whewell, the latter of whom was an expert in languages (and at coining terms), he published his findings together with a list of words that he wished to introduce to the science [28, 29].

New word	Greek etymology
Electrolysis	ἤλεκτρον (amber) + λύειν (set loose, release)
Electrode	ἤλεκτρον (amber) + ὁδός (path, way)
Electrolyte	ἤλεκτρον (amber) + λύειν (set loose, release)
Anode	ἀνά (up) + ὁδός (path, way)
Cathode	κάτω (down) + ὁδός (path, way)
Ion	ἰόν (that which goes)
Anion	ἀνιόν (that which goes up)
Cation	κατιόν (that which goes down)

<sup>15</sup> The six elements were: magnesium, barium, strontium, potassium, sodium and calcium. For details, including his naming of several elements, see [26].

*'These terms, being once well defined, will, I hope, in their use enable me to avoid much periphrasis and ambiguity of expression. I do not mean to press them into service more frequently than will be required, for I am fully aware that names are one thing and science another.'*<sup>16</sup>

Electrical decomposition became 'electrolysis'. A battery was connected to a solution (the 'electrolyte') with two 'electrodes'. The electrode that was positively charged was called the 'anode'; the electrode that was negatively charged was called the 'cathode'.

The decomposition of a compound formed two substances which collected on the electrodes. Faraday assumed that this was due to electrostatic attraction, and therefore the substances, or 'ions', must be charged. Even though the electrodes were often placed side by side, Faraday and Whewell thought of a gravitational analogy for the electrical circuits. They placed the anode at the top, and the cathode at the bottom. Ions that were positively charged (in excess of charge) sank to the bottom and collected on the cathode. They were called 'cations'. Any ions that were negatively charged (lacking in charge), like a bubble, floated to the top and collected on the anode. They were called 'anions'. Anything that was electrically neutral remained floating around in the electrolyte.

During this time, when more quantitative measurements of electrical experiments were possible, the quantity and rate of flow of the electric charge was found wanting of algebraic representation. Physicists such as Faraday, and the French physicists Coulomb and Ampere, excelled in these sorts of experiments and it is their conventions that persist through history.

The French called the amount of charge the 'quantité d'électricité'; the English similarly called it the 'quantity of electricity', as did many English speaking scientists. We now denote charge with the symbol **Q** for quantity. They also called the strength of this current 'l'intensité du courant électrique' (the intensity of the electric current). We now denote current with the symbol **I** for 'intensity'.

<sup>16</sup> The table is based on the footnotes of [29, p 79] (paragraph 666). It was helpfully rewritten by my friend Claire Hall (Trinity, Cambridge: [ch573@cam.ac.uk](mailto:ch573@cam.ac.uk)). The Greek now has additional breathing accents and is consistently in neuter participles, which is not the case in Faraday's original paper.

### George Johnstone Stoney (1826–1911) and J J Thomson (1856–1940)

During his experiments, Faraday discovered a pattern now known as 'Faraday's Law of Electrolysis'. In 1874 George Stoney stated Faraday's observations in the following way:

*For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte which is the same in all cases* [30].

Later, In 1894, Stoney remarked upon his previous comments:

*'In this paper an estimate was made of the actual amount of this most remarkable fundamental unit of electricity, for which I have since ventured to suggest the name electron'*<sup>17</sup>.

It is fitting George Stoney chose the Greek word for amber, where our story started. Electrons were thought to be the constituents of electrical current and also cathode rays, newly discovered phenomena in which beams could be made to emanate from a cathode.

The discovery of the electron (by Thomson in 1897 [32]) and the measurement of its charge (by Millikan in 1913 [33])—together with the subsequent explanations of electrostatic phenomena in terms of the electron—suggests two errors in Benjamin Franklin's work.

Firstly, the charge is not a continuous fluid, but particulate. Despite this, we still say 'the flow of charge' and talk of 'currents' as Franklin did. But, after a small reminder, we still do this with rivers and we think they are made of particles too.

The second error in his work is far more unfortunate. As Franklin was unable to *observe* the direction in which his electrical fire moved, he had to guess which way it flowed during charging or discharging. Sadly for his heirs, he got the direction the wrong way around. An object that he considered to be positively charged (in excess of his electrical fluid) we now know to be *lacking* in electrons.

Despite this, students are still taught: 'charge flows from positive to negative' in simple electrical circuits. This is justified by talking about

<sup>17</sup> Reference [30]. For an account of how the electron was proposed, see [31].

'conventional current'—which is a euphemism for the historical error. The conventional current is also a fictitious current, yet the historical origin of this strange idea is rarely taught. It is like claiming 'cold' or 'dark' can be described positively, rather as a negation of other processes (heat and light).

Furthermore, notice that the electron is designated the charge of  $-1$ . It is the unit of charge, the first fundamental particle to be discovered, yet is assigned the charge of  $-1$ . It is akin to operating with the unit of energy as  $-1$  J!

To put it another way, if the electron truly is the fundamental carrier of this property called 'charge', wouldn't it be much more useful to take it as the true unit of charge, giving it a charge of  $+1$ ? We could say that objects with positive charge will have an excess of electrons, correcting Franklin's mistake. Then, charge really would move from positive to negative in electrical circuits.

Unfortunately, our ancestors have chosen a policy of non-interference with historical vocabulary, choosing to retain scientific relics at the expense of clarity. If we continue this habit, we are left defending the strange consequences of assigning the electron a charge of  $-1$  and claiming that it travels in the opposite direction to the conventional current. The electron then becomes the salmon of electricity; swimming upstream in a ghostly river of conventional current.

The author of the popular webcomic XKCD (see figure 1) once imagined what an electrical engineer would do if given a time machine. The scientist in the comic chooses to use their ability to go back in time and warn Franklin of his inconvenient error.

*'Sure, we could stop dictators and pandemics, but we could also make the signs on every damn diagram make sense' [34].*

Michael Faraday was aware that he and his contemporaries were operating under an assumption regarding the current direction, but how many present day teachers and students are aware that this unfortunate guess was the cause of our strange vocabulary?

*'It will be well understood that I am giving no option respecting the nature of the electric current now, beyond what I have done on former occasions; and that though I speak of the current as*



**Figure 1.** An image from the webcomic XKCD. Reprinted with permission from [xkcd.com](http://xkcd.com).

*proceeding from the parts which are positive to those which are negative, it is merely in accordance with the conventional, though in some degree tacit, agreement entered into by scientific men, that they may have a constant, certain, and definite means of referring to the direction of the forces of that current' [35].*

## 20th century physics and the future

Since the discovery of the electron, our concept of it has greatly changed. 20th century quantum mechanics revealed inadequacies in the classical physics of our story so far. Amusingly, in 1937, G P Thomson was awarded the Nobel Prize in Physics for showing that cathode rays can diffract and thus behave like waves—31 years after his father won the same prize for discovering them as particles!

The modern theory of quantum electrodynamics (QED), a theory of light's interaction with electrons, models both as 'quantum objects'. They are neither particles (ball-like) or waves (water-wave-like). Thus, the electric vocabulary has changed meaning once again, residing in more abstract ideas.

With the progress of particle physics in the 1960s came descriptions of other fundamental particles with a smaller charge than the electron. These ‘quarks’ have either one third or two thirds the amount of charge of one electron.

Again, at this point in history physicists could have decided to re-label all fundamental particles and declare the down quark as the unit of charge, assigning it a charge of +1 (making the electron now +3). This did not happen. The electron retains its strange defining role, and we are once again left with a consequence of nothing more than an historical quirk: the quarks have fractional charge.

Incidentally, the strange quark suffered a similar chance error as the electron. When Murray Gell-Mann proposed the existence of the strange quark, he was trying to explain the asymmetry between decay times of certain particles (the *strange* asymmetry). Through further study, looking for symmetry elsewhere, he proposed a conservation of strangeness, just as Franklin had thought the electric fire was conserved [36]. However, when the strange particle was eventually discovered, it was found where the anti-strange particle was supposed to reside. Hence, the strange quark has ‘strangeness’ of  $-1$ , for similar reasons that the electron has charge  $-1$ .

Of course, there are terms used in other fields of physics that also originate from falsified theories. ‘Calorie’, a popular unit of energy, originated from a theory of heat which utilized a substance called ‘caloric’, since proven to be imaginary. The ‘atom’, a concept we still retain, derives from the Greek word ἄτομος (atomos) meaning ‘uncuttable’—yet we now know it *is* cuttable.

The persistence of such terms is problematic, but given that they do persist, an acquaintance of their origins is essential. As Faraday said, a grasp of the meaning of words is very different from an understanding of the cosmos. However, I would argue that a narrative of the history of classical electrical theory is a valuable asset to teaching. It enables students to see through the accident and whimsy of the subject so they can more clearly view the patterns of our world that the science describes.

Received 11 November 2011, in final form 22 November 2011  
doi:10.1088/0031-9120/47/1/78

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