

The history of Light, electricity and magnetism. Towards Space-time

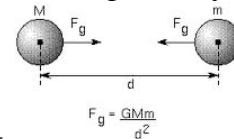
Actually I don't know the earlier views on light ¹ but it is clear that human beings since the beginning have experienced light as well as gravity.

About 500 B.C. discoveries of both magnetic force and static electrical force were made. Both could counteract gravity and both differed drastically from gravity that they have two qualities attraction and repulsion. But all these phenomena were, as far as I know, in a scientific meaning seen as separate.

During the sailings (in 13th 15th centuries) when the compass was used in the occident the sailors noted that the compass rotated fastly as a thunderbolt or lightning was seen, so thunderbolt has something to do with magnetism. (I don't know if same observations was recorded in China where compass has been used since 200 B.C.)

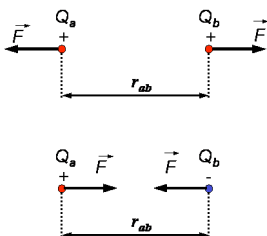
In 1675, the Danish astronomer Ole Roemer while observing Jupiter's moons, came to the conclusion that light must have travelled at 200,000 Km/s.² (which is right order of magnitude but not the exact modern value of 299792.458 km/s)¹

Newton succeeded about 1680 to describe both movement on Earth and planetary movements



using $F = m \cdot a$ and his famous formula for gravity $F_g = G \frac{Mm}{d^2}$

Coulomb³ 1783 showed the “same” formula $\vec{F} = K \frac{Q_a \cdot Q_b}{r_{ab}}$ for electrical charges



And the same mathematical formula can be used with magnets , though the it differs as magnetic poles always came as pairs.

¹ Find now this interesting note “But 1400 years ago it was stated in the Quran (Koran, the book of Islam) that angels travel in one day the same distance that the moon travels in 1000 lunar years, that is, 12000 Lunar Orbits / Earth Day. Outside gravitational fields 12000 Lunar Orbits / Earth Day turned out to be the known speed of light!” When I count it I get 368820km/s again right order of magnitude! (I used a value of the speed of the moon 1.023km/s so we get $1,023 \cdot 1000 \cdot 12 \cdot 30 \cdot 24 \cdot 3600 / 24 \cdot 3600$) But doing some plausible correction, which I haven't checked the Koran measure gives the exact value http://www.speed-light.info/speed_of_light_12000.htm)

² “In 1675, the Danish astronomer Ole Roemer noticed, while observing Jupiter's moons, that the times of the eclipses of the moons of Jupiter seemed to depend on the relative positions of Jupiter and Earth. If Earth was close to Jupiter, the orbits of her moons appeared to speed up. If Earth was far from Jupiter, they seemed to slow down. Reasoning that the moons orbital velocities should not be affected by their separation, he deduced that the apparent difference must be due to the extra time for light to travel when Earth was more distant from Jupiter. Using the commonly accepted value for the diameter of the Earth's orbit, he came to the conclusion that light must have travelled at 200,000 Km/s” <http://www.speed-light.info/measure/roemer.htm>

³ “Coulomb's law or Coulomb's inverse-square law, is a law of physics describing the electrostatic interaction between electrically charged particles. It was studied and first published in 1783 by French physicist Charles Augustin de Coulomb and was essential to the development of the theory of electromagnetism. Nevertheless, the dependence of the electric force with distance had been proposed previously by Joseph Priestley[1] and the dependence with both distance and charge had been discovered, but not published, by Henry Cavendish, prior to Coulomb's works.” http://en.wikipedia.org/wiki/Coulomb's_law

Benjamin Franklin the American statesman and scientists thought 1750 that thunderbolt could be electrical as it looked like the electrical sparks though very huge. So to more prove this thought a French scientist. Dailbard and then Franklin put up a kite with a conducting wire, and when a thunderbolt hit the kite which was connected to a electroscope this was charged supporting the view that thunderbolt was of electrical nature.⁴

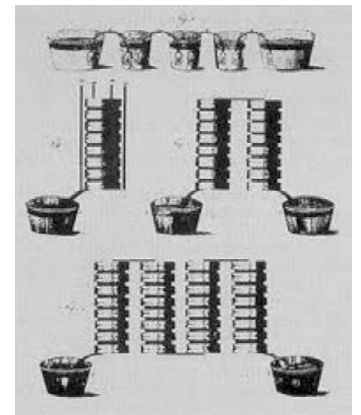
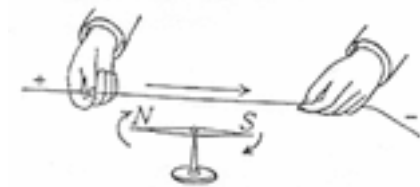
Thus the thunderbolt was had both electrical and magnetical effects so the question came about a relation between electricity and magnetism. At that time electricity could only be produced by friction and give short-lived sparks.

1762 Galvani, a professor of anatomy used a machine to produce sparks and his assistant examining an unfortunate dead frog saw that the leg of the frog jerked as a electrical spark was produced.

Galvani made, what later showed be correct, the supposition that muscles reacted on electricity and that there must exist intrinsic animal “magnetism” or electricity.

Professor Volta, a physicist, argued against this suggesting that the electricity which made the leg jerk was produced by a pincette made of two metals. It is not clear to me how he came to that idea but to prove that he was right he constructed Volta’s pile 1798 , the first electrical battery which produced a continuous electrical current (of course you must prove that the current is of the same nature as the electrical sparks but one way to make this plausible is the observation that from a battery you can also get electrical sparks.)

Now Hans-Christian Oersted 1815⁵ could do his famous experiment showing how an electrical current through a wire produced magnetic forces. But not like a magnetic bar but forces in circles around that wire, which according to Einstein was the first step away from the mechanistic view where all forces was directed along the line between the objects.



Then Michael Faraday 1831 discovered the reverse that is how a changing magnetic force could give electrical current⁶, which is the basis of how we nowadays produce electrical current It was also Faraday who introduced the concept of field for magnetic and electrical forces and a field can perhaps most easily be thought of as a possible force.

⁴ http://en.wikipedia.org/wiki/Benjamin_Franklin#Electricity
<http://www.mos.org/sln/toe/kite.html>

⁵ Some say it was discovered earlier but en electrostatic effect.
http://en.wikipedia.org/wiki/Gian_Domenico_Romagnosi

⁶ Suggested the year before http://en.wikipedia.org/wiki/Francesco_Zantedeschi

Faradays pupil James Clark Maxwell was a brilliant mathematician and could synthesise all experimental facts about electricity and magnetism in his famous equations . Solving these

showed electromagnetic waves with the velocity $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \approx 3 \cdot 10^8 \text{ ms}^{-1}$ that is

the same as that of light, now derived from pure electrical and pure magnetical measurements showing a deep connection between electromagnetism and light so the text around the equation below is significant

And God said

$$\begin{array}{lll}
 \oint \vec{E} \cdot d\vec{l} = - \int \frac{\partial \vec{B}}{\partial \tau} \cdot d\vec{s} & \nabla \times \vec{E} = -\mu \frac{\partial \vec{H}}{\partial \tau} & \nabla \times \vec{E} = -\mu \frac{\partial \vec{H}}{\partial \tau} \\
 \oint \vec{H} \cdot d\vec{l} = \int \left(\vec{J}_c + \frac{\partial \vec{D}}{\partial \tau} \right) \cdot d\vec{s} & \text{OR } \nabla \times \vec{H} = \vec{J}_c + \epsilon \frac{\partial \vec{E}}{\partial \tau} & \text{OR } \nabla \times \vec{H} = \vec{J}_c + \epsilon \frac{\partial \vec{E}}{\partial \tau} \\
 \oint \vec{D} \cdot d\vec{s} = \int \nabla \cdot \vec{D} d\tau & \nabla \cdot \vec{D} = \rho_v & \nabla \cdot \vec{D} = \rho_v \\
 \oint \vec{B} \cdot d\vec{s} = 0 & \nabla \cdot \vec{B} = 0 & \nabla \cdot \vec{B} = 0
 \end{array}$$

and there was light

Before Einstein it was thought that light waves and other electromagnetic waves was travelling in the ether, (or perhaps even thought waving in the ether as water waves wave in water and sound waves wave air).

But according to the old view of movement and Maxwells equation for electromagnetic waves light would have a special velocity (in vacuum) in just one system, which then was thought of as the ether. But then light would have different velocities relative different observers moving relative each other. But experiment could never find any different velocity for light! And it was the genius of Einstein, to against the empirical and theoretical knowledge that all other known phenomena has different velocities relative to systems which move relative each other, from just a couple of experiments formulate the bold Postulate :

The velocity of light in vacuum is the same in all systems.

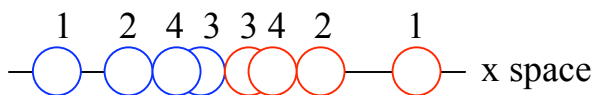
Then the ether as a special system for light was not needed and thus was abandoned and light and electromagnetic waves was viewed to be able to travel trough vacuum.

On the other hand Einstein's postulate led to a totally new view of space and time. He called the theory "*the theory of relativity*" but pondered to call it the theory of the absolute. Because besides that it showed that not only velocity was relative, ie have different values for different observers, which we already know since Galileo, but also space, length (objects become shorter when

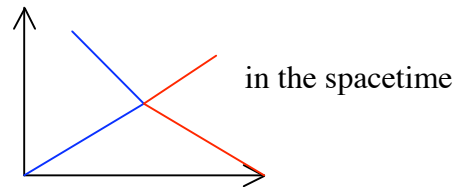
move), time (goes slower), simultaneity , all also are relative, the theory also showed what was absolute ; the velocity of light in vacuum and the “space-time distance” between any two events. This is well described by Minkowski

.. the word *relativitypostulate* for the requirment of an invariance... seems to me very feeble. Since the postulate comes to mean that only the four-dimensional world in space and time is given by phenomena but that the projection in space and time may still be undertaken with a certain degree of freedom, I prefer to call it the *postulate of the absolute world* (or briefly, the world –postulate)

the spheres move
in space along x



but this can be pictured



And I think spacetime is a better candidate to be the western scientific concept related to the eastern ether.

The four-dimensional spacetime is absolute but space and time taking separately is relative so spacetime seems to be the more basic concept. I have elsewhere (see Abstract1) argued that the near-death-experience where people can see their whole life at once can easily be interpreted as the experience the time dimension as space and thus experience the fourdimensional spacetime which then is not only basic and ontological real but also open for experience.(Which to my mind makes this theory better than the speculation of 11 dimensions in stringtheory which has no empirical or experiential counterpart)