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Correct Visualization of Forces Between Balanced Zero-Net-Charge Atomic Particles

By Morton F. Spears
http://www.econ.iastate.edu/tesfatsi/MFSpears/

Abstract: In standard introductory physics textbooks, one finds the following claim: The positively charged proton and the negatively charged electron in an atom such as hydrogen cancel each other for all outside generation of electrostatic forces. This claim is incorrect due to a non-reciprocal characteristic of atoms. This paper provides a brief explanation of this experimentally determined non-reciprocal effect using simple hydrogen atom examples for concrete illustration.

In standard introductory physics textbooks, one finds the following claim: The positively charged proton and the negatively charged electron in an atom such as hydrogen cancel each other for all outside generation of electrostatic forces. This claim is incorrect due to a non-reciprocal characteristic of atoms. The explanation to follow will use two hydrogen atoms to demonstrate this non-reciprocal effect.

As usual, suppose one models a hydrogen atom as a spherical body with an approximate radius of 5.28×10^{-11} meters. This body consists of an electron having an approximate radius of 2.82×10^{-15} meters (classical electron radius) rotating on the perimeter of the body around a proton located at the center of the body. The ratio of the separation distance between the electron and proton to the electron radius is about 18,720. Scaling this up into American sports terms, let the electron be represented by a half-inch radius ping-pong ball, which is then some *260 yards away* from the proton (roughly the size of a basketball). Now put a charge on the ping-pong ball. Can anybody possibly think that the charge on this tiny ping-pong ball communicates only with the opposite charge on the basketball over two full football fields away (including end-zone areas)? Or, can one believe a charge on the basketball communicates only with the opposite charge on the tiny ping-pong ball over two football fields away? The answer seems obvious. Of course the electron exerts a field external to the hydrogen atom, as does the proton. Do they cancel each other? Not likely; each field acts separately from separate relatively far-spaced sources.

Next consider what happens when the fields exerted by the electron and proton for the given hydrogen atom interact with a second object, such as a second hydrogen atom. Suppose this second hydrogen atom is located far from the first hydrogen atom (more than a micrometer away, for example). In this case, the proton and electron comprising the second hydrogen atom are so closely spaced from the vantagepoint of the first hydrogen atom that their charges appear to cancel each other. That is, the second hydrogen atom is an effectively zero-charged particle with a mass equal to the sum of the proton and electron masses. What happens is that the field associated with the negatively charged electron and the field associated with the positively charged proton from the first hydrogen atom act upon this effectively zero-charged particle. As verified by scale modeling experiments, this produces an attractive force on this particle. Of course, from the vantagepoint of the second hydrogen atom, its proton and electron each attract the effectively zero-charged first hydrogen atom.

What we all learned in introductory physics courses is that a balanced zero-net-charge particle is attracted to an external single charge such as an electron or a proton because the charges within the particle displace themselves to cancel the impinging field. That is, the standard explanation is as follows. If the external single charge is negative, the positive charges within the particle move nearer to it. Conversely, if the external single charge is positive, the negative charges within the particle move nearer to it. In either case, the result is an attractive force between the external charge and the particle because the attractive charges are closer together than the repelling charges. Such attractive forces are referred to as Coulomb attractive forces.

Consider, again, the case of two hydrogen atoms sufficiently distant from each other so that each is an effectively zero-charged particle from the vantage point of the other. Let the Coulomb force argument of the previous paragraph be applied to the second hydrogen atom viewed as acted upon simultaneously by the electric fields associated with the negatively charged electron and the positively charged proton of the first hydrogen atom. With two opposite polarity fields there is no net displacement of the charges in either hydrogen atom. Hence, aside from normal dipole forces, the net force between the atoms should be zero. Dipole forces are dependent on the spacing between the two charges of the dipole (first hydrogen atom) and the orientation of the dipole with respect to the particle it acts upon (the second hydrogen atom).

However, in violation of this Coulomb concept of forces, experiments demonstrate that there is a *non-zero* force between a balanced zero-net-charge particle and a very short plus and minus charged dipole that is not attributable to normal dipole forces. Unlike normal dipole forces, this non-zero force consists of two independent additive forces from each charge of the dipole that are projected omni-directionally and do not depend on the spacing between the two charges of the dipole. The magnitude and the sign (attraction or repulsion) of this non-zero force are determined by the relative resistivity and permittivity of the particle to the medium surrounding it. For example, a particle with either low resistivity or high permittivity relative to its background will be attracted to the dipole (e.g., a small metal ball in vacuum or air). Conversely, a particle with high resistivity and low permittivity relative to its background will be repulsed by the dipole (e.g., a small plastic ball in distilled water that has sufficiently lower permittivity and higher resistivity than the water).

If all of the above is true, why haven't experimenters all over the world already acknowledged such a force? They have, without realizing it. It is a force they deal with continually every day. The force is called *gravity*. Indeed, experiments support the following simple but elegant result. If the electrical circuits involved with the capacitances between charged and uncharged particles are appropriately analyzed, the magnitudes of the resulting forces agree (within about 0.2 percent) with the purely empirical magnitudes that have heretofore always been used and accepted for gravity.

If the reader would like to learn more about the electrical circuits and methods used to determine the above findings, please consult the following on-line report:

Morton F. Spears, "*An Electrostatic Solution for the Gravity Force and the Value of G*," January 9, 1997. http://www.econ.iastate.edu/tesfatsi/MFSpears/mfsgravity.g.figs.pdf