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From the Editor's File of Important Letters:

Comment on an Asserted Equivalence

In 2006, C. van der Togt proposed an equivalence of magnetic and kinetic energy, at least for all charged particles. This comment proves that his system of equations is logically inconsistent. It thus turns out that the said equivalence cannot possibly be a law of physics.

1. Introduction

In his 2006 paper "The Equivalence of Magnetic and Kinetic Energy", C. van der Togt proposed a new general principle of physics; namely, that the energy stored in the magnetic field around a moving charged particle is always identical to its kinetic energy. In that paper, magnetic energy W_{m} of a single moving charge was defined as:

$$W_{\mathrm{m}} = L \cdot I^2 \tag{1}$$

Here L is the coefficient of magnetic induction of an electric circuit that the charge traverses, and I is the (electric) current in that circuit. Kinetic energy W_{k} of a single particle is defined as:

$$W_{\mathrm{k}} = m \times v^2 / 2 \tag{2}$$

where m is the mass of the particle. The proposed general principle is then

$$W_{\mathrm{m}} = W_{\mathrm{k}} \tag{3}$$

for all charged particles.

In §2 it will be shown that the proposed result is logically at fault (inconsistent). In §3, the main implication of this result is briefly discussed.

2. Proof of Logical Inconsistency

Proposition: The axiomatic system determined by the equations (1-3) is logically inconsistent.

Proof: In separate experiments, let a hydrogen nucleus H^+ and a deuterium nucleus D^+ move with the same speed v in the same medium (*e.g.* a vacuum). Both particles have the same charge q; using the general expression for current I due to moving charge, *cf.* [2], the current is then for both cases given by

$$I = k \cdot q \cdot v \tag{4}$$

Here k is the number of linearly aligned point charges per meter; since each of the two experiments concerns a single particle, $k = 1\ \mathrm{m}^{-1}$. Furthermore, since both experiments are performed in the same medium, the value for L is the same; using (1), it thus logically follows that the *magnetic* energies $W_{\mathrm{m}}(\mathrm{D}^+)$ and $W_{\mathrm{m}}(\mathrm{H}^+)$ stored in the fields of the corresponding two nuclei are identical:

$$W_{\mathrm{m}}(\mathrm{D}^+) \equiv W_{\mathrm{m}}(\mathrm{H}^+) \tag{5}$$

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However, because the mass of D^+ is twice the mass of H^+ and the speed v is the same for both D^+ and H^+, on account of (2) the following equation holds for the *kinetic* energies $W_k(D^+)$ and $W_k(H^+)$ of these two nuclei:

$$W_k(D^+) = 2 \cdot W_k(H^+) \tag{6}$$

On account of (3), the following identities hold:

$$W_m(D^+) = W_k(D^+) \tag{7}$$

$$W_m(H^+) = W_k(H^+) \tag{8}$$

But substituting (5) and (6) in (7) yields the equation $W_m(H^+) = 2 \cdot W_k(H^+)$, so that

$$W_m(H^+) \neq W_k(H^+) \tag{9}$$

Comparing (8) and (9), it has been demonstrated that at least for one formula Ψ, both Ψ and $\neg\Psi$ can be derived from (1-3). Q.E.D.

3. Main Implication

This inconsistency result refutes the axiomatic system, with Eqs. (1- 3) as its non-logical axioms, as a true model of reality: there is thus no such thing as equivalence of magnetic and kinetic energy for all (charged) particles in the real world.

It is true that (4) has been used in addition to (1-3) to prove the inconsistency, but (4) is not an expression that is not implied by the system: the use of (4) is justified – this is classical mechanics. The point is that the *same* magnetic energy (1) can be stored in the magnetic fields of charged particles having *different* kinetic energies (2). The inconsistency thus also occurs when the magnetic and kinetic energies of other particles with the same charge but different masses (*e.g.* an electron and an antiproton, or a proton and a positron) are compared.

References

[1] C. van der Togt, "The Equivalence of Magnetic and Kinetic Energy", Galilean Electrodynamics **17** (6), 110-114 (2006).

[2] H.D. Young, R.A. Freedman, **University Physics**, 9th ed. p. 801 (Addison-Wesley, Reading, 1996)

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Editor's Comment

It is indeed interesting to pursue the idea that magnetic fields are the genesis of physical phenomena that, to humans, appear to merit completely distinct names. For example, within a magnetic energy, Mr. van der Togt saw a kinetic energy. Here Mr. Cabbolet found the idea original, but objected to equating those energies, mainly because mass plays a role that in the definition of kinetic energy, but not in the expression for magnetic energy.

I am inclined to look past the idea of kinetic energy of a neutral particle, presumably free, and instead to the idea of potential energy of a charged particle, presumably interacting with another charge. On a time-average basis, an electron orbiting in the field of an atomic nucleus has a negative potential energy of magnitude equal to twice its kinetic energy. So rather than the kinetic energy, I am personally inclined to look to potential energy of attraction for some sort of connection with magnetic energy.

Looking deep into history, before Maxwell, Ampère had a well-developed theory about forces between what he called 'current elements'. This term referred to charge neutral differential increments in electrical circuits. Ampère's theory works perfectly well for ordinary closed circuits, and also for incomplete broken circuits such as may exist momentarily in transient situations like explosions. It ought not be forgotten solely on the basis that more modern theory also works perfectly well for ordinary closed electrical circuits. Indeed, in some technological applications, this older theory explains more than the modern theory does. [1]

What can Ampère's theory suggest about gravity? Instead of neutral current elements, please think about neutral atoms. At any moment in time, any atom is like a current element, inasmuch as the electrons are moving, and the nucleus is moving not so much.

Add to this a rather hierarchical vision of atoms in general, in which the electrons are a rather self-contained subsystem that has internal interactions, but overall orbits the nucleus a lot like the single electron orbits the proton in the prototypical Hydrogen atom. That will make for a time-varying Ampère force between any two atoms. It will be sometimes attractive, sometimes repulsive. That means a time varying potential energy, sometimes negative, sometimes positive.

Now a central concept in statistical mechanics and thermodynamics is that lower energy states are populated more than higher energy states are. That concept means our two atoms will be in a state of negative potential energy more often than in a state of positive potential energy. So they will, on average, attract each other.

So what have we got here? Is this a candidate explanation for the phenomenon of gravitational attraction? It is certainly something to work on!

References

[1] Peter Graneau, **Ampere-Neumann Electrodynamics of Metals** (Hadronic Press, Inc. Nonantum MA, 1985).

[2] Cynthia Whitney, **Algebraic Chemistry: Applications and Origins** (Nova Science Publishers, New York, 2013).

CKW