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# We Live in a World Where Non-conservation of Linear Momentum is a Common Phenomenon

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According to Newton's laws, two bodies can interact with one another with forces that are equal in magnitude and opposite in direction. The force is equal to the time rate of the linear momentum flow:

$$\vec{F} = \frac{\partial}{\partial t}\vec{P} \qquad (1)$$

The equality of forces actually means the conservation of linear momentum. This is understandable if the bodies are in direct physical contact. But what if the bodies are at a distance in a vacuum and interact through a constant electric (or magnetic) field? One body loses linear momentum and another gains the same amount – but where is the flow of linear momentum between them? There flows nothing between them (T03=0). The linear momentum disappears from one body and appears at the other. A constant electric field charge of the body just defines the rate (force) and makes sure the rates are equal! It is the proof of the statement made in the title of this article. Probably this was noticed previously by someone and I would appreciate any information regarding it. Below is the math to support this idea.

Let us make some calculations. Suppose we have an electron resting between the plates of a capacitor that creates a constant electric field E. As usual, we replace the electron with a thin layer of a material continuum that has a charge, Q per square unit. The layer is positioned from z=0 to z=a. We have:

$$\begin{aligned}
&\Phi_1 = -Ez + C_1; \quad E_1 = E; \quad \Phi_2 = -\frac{E}{k_0}\sin k_0 z + C_1 \cos k_0 z \\
&E_2 = E\cos k_0 z + k_0 C_1 \sin k_0 z; \quad \rho = \frac{k_0^2}{4\pi}{}_2A^0; \quad C_1 = \frac{4\pi Q + E(1-\cos k_0 a)}{k_0 \sin k_0 a} \\
&\Phi_3 = -(E + 4\pi Q)(z-a) + C_2; \quad C_2 = \frac{4\pi Q \cos k_0 a + E(1-\cos k_0 a)}{k_0 \sin k_0 a} \\
&E_3 = E + 4\pi Q
\end{aligned} \qquad (2)$$

We have only the scalar potential (ether quantity) that does not depend on time (which fulfills ether conservation). The potential in the second region (material continuum) must satisfy the equation:

$$\Phi_2'' - \frac{1}{c^2}\ddot{\Phi}_2 = -k_0^2 \Phi_2 \qquad (3)$$

All the constants are chosen so that the potential and its first derivative are continuous at the boundaries. One shouldn't be surprised that the electric field in the vacuum in the 3rd region is influenced by the charge, Q. The energy momentum tensor in this symmetry is:

$$T^{00} = T^{11} = T^{22} = \frac{1}{8\pi}E^2 - \frac{2\pi}{k_0^2 c}\rho^2; \quad T^{33} = -\frac{1}{8\pi}E^2 - \frac{2\pi}{k_0^2 c}\rho^2; \quad T^{03} = 0 \tag{4}$$

The electric field is continuous at the boundaries. This means that the jumps of T33 (only these jumps will create the sources of linear momentum) will be due only to the jumps of the charge density. We have:

$$T^{33}(z = 0+) - T^{33}(z = 0-) \equiv \Delta_1 = -\frac{C_1^2}{8\pi}; \quad \Delta_2 = \frac{C_2^2}{8\pi}; \quad -(\Delta_2 - \Delta_1) = Q\left(E + \frac{4\pi Q}{2}\right) \tag{5}$$

It appears that the force equals the charge multiplied by the average electric field between the first and third vacuum regions.