Electric Energy from Physical Vacuum Space

Kiyoung Kim[1]

Abstract

The law of conservation of energy, one of the first principles in physics, has been believed without a doubt; thus, it is natural that all scientific paradigms also have been built on the basis of the first principle. However, it is true that the first principle is based on empiricism, saying that any violation of energy conservation has not been observed or confirmed in objectivity. Meanwhile, there have been many pioneering researches for free electric energy generation challenging for the first principle although none of them has been acknowledged openly in public yet. However, in the new paradigm of physics including ontological reality in 4-D complex space, the free electric energy generation is explained how it is possible and why the conventional energy conservation law is not valid.

[1] kkim.pvn@gmail.com

Introduction

As we have believed in the law of conservation of energy like a religious doctrine, we have believed that all physical interactions occur only in phenomenological world. However, the ontological reality of physical vacuum and its interactions with physical phenomena has been hypothesized with 4-D complex space introduced as physical space, in which the physical vacuum in the physical space, which has been considered as just empty space in conventional scientific consensus, is completely filled with vacuum particles, those of which interact with physical objects in phenomena; physical interactions, such as gravitational interaction, electric interaction, magnetic interaction, or electromagnetic interaction, can be explained uniquely with the first principle in the physical space. (Kim 1997, 2008, 2017) Now, we can understand physical interactions, more than ever, not just conceptual meanings based on phenomenology but fundamental mechanisms in new paradigm of physics as above.

For instance, in gravitational interaction the potential energy is a representation for the status of vacuum particles rearranged against any disturbance, which is made by an external force in phenomena, for the equilibrium status in physical space, and for the status of being ready to come back to the original equilibrium status whenever it is possible; thus, gravitational potential energy is being connected directly to gravitational interaction and the corresponding energy exchanges between kinetic energy and potential energy is made through the gravitational interaction only. By the same token, electric potential energy or magnetic vector potential is also being connected to electric interaction or magnetic interaction, respectively. However, as shown in Maxwell's equations, electric field and magnetic field are not independent from each other, in general. For instance, if electric field is varying with time or an electric charge is in motion, magnetic field is induced or the variation of magnetic field is accompanied.

Now, let's investigate the mechanism how electric field and magnetic field interact to each other in phenomena and how corresponding electric field energy and/or magnetic vector potential energy is produced and how the form of energy is transformed to each other, from which we can review the law of conservation of energy with the physical vacuum mentioned above and we can investigate whether free-energy source in physical vacuum is possible or not.

It seems that the question about free-energy has a long history; in the Middle Ages, long before the birth of Newtonian mechanics, a mechanical device, so-called Bhaskara's wheel, was invented, and the inventor insisted that it can go forever by itself -- perpetual moving machine. Even at now, 21th century modern society, some followers insist that the Bhaskara's wheel or one designed similarly is possible as a perpetual moving machine. If that is true, we have to explain how it is possible and where the extra energy is coming from. However, in classical mechanics, gravitational force is known to be conservative as $\bar{F}_G = -\nabla\Phi$ in which Φ is gravitational potential; thus $\nabla\times\bar{F}_G = 0$, which means that we cannot expect any energy gain or loss in the system through any repeating mechanical process. More in detail, it has been explained that the perpetual moving machine is not possible. (Simanek 2010)

On the other hand, Lorentz force, for instance, let's say, an electric charge is moving under the influence of electromagnetic fields, has two terms as $\vec{F}_L = q\left(\vec{E} + \vec{\upsilon} \times \vec{B}\right)$, in which the second term is not the central force that can be derived as $\vec{F} = -\nabla\varphi$ from a scalar function φ; thus, which is conservative force $\left(\nabla \times \vec{F} = 0\right)$ as in gravitational force, coulomb force, or simply the spring force in a simple harmonic oscillation, but in perpendicular direction to the moving charge, which means that the force doesn't make any mechanical work for the moving charge. Anyhow, according to the definition of conservative force, Lorentz force is not conservative in general because $\nabla \times \left(\vec{E} + \vec{\upsilon} \times \vec{B}\right) = -\frac{d}{dt}\vec{B}$, which reminds of the Faraday's law of induction and the time variation of magnetic flux in a closed loop. If the magnetic field is time independent as $\frac{d\vec{B}}{dt} = 0$, Lorentz force is conservative; however, if $\frac{d\vec{B}}{dt} \neq 0$, the Lorentz force is not conservative and the kinetic energy of the charge moving in the magnetic field $\vec{B}\left(\vec{r}, t\right)$ can be changed; also magnetic field energy in space can be changed together.

In general, electric field and magnetic field are not independent from each other as shown in Maxwell's equations, and the energy in system can be transferred to different forms, such as electric, magnetic, and electromagnetic energy, through a mechanical work process and field interactions as shown in Maxwell's equations. However, even in the case of $\frac{d\vec{B}}{dt} \neq 0$, the law of conservation of energy cannot be challenged in conventional physics paradigm. From Hamiltonian formulation and/or using least action principle in Euler-Lagrange equation, the energy conservation in electromagnetic fields can be confirmed as long as no external source is involved.

However, for a charged particle moving under the influence of electromagnetic fields given as $\vec{E} = -\nabla\phi - \frac{\partial\vec{A}}{\partial t}$ and $\vec{B} = \nabla \times \vec{A}$ $\left(\phi:\ \text{electric scalar potential}, \vec{A}:\ \text{magnetic vector potential}\right)$, there are some interesting facts in Hamiltonian, $H = \frac{1}{2m}\left(\vec{\mathrm{P}} - q\vec{A}\right)^2 + q\varphi$, in which canonical momentum $\vec{\mathrm{P}} = m\vec{\upsilon} + q\vec{A}$ $\left(\vec{\upsilon}:\ \text{velocity of charge } q\right)$ and in Lagrangian function, $L = \frac{1}{2}m\upsilon^2 - q\varphi + q\left(\vec{A} \cdot \vec{\upsilon}\right)$. The canonical momentum includes the vector potential as

$\vec{P} = m\vec{\upsilon} \Rightarrow \vec{P} = m\vec{\upsilon} + q\vec{A}$, and the Lagrangian function includes the term with vector potential in addition to the scalar function φ as $\varphi \Rightarrow \varphi - (\vec{A}\cdot\vec{\upsilon})$.

In 4-D complex space, which is the physical space in new paradigm of physics, once ontological interpretations are given with the first principle in the space; such as what is electric field, what is magnetic field, and how they interact to each other, which appears in phenomena as shown in Maxwell's equations, the minimal coupling in canonical momentum and the additional term including vector potential in Lagrangian function can be understood easily how the vacuum particles react against the current effect in the space.

Faraday's Law of Induction and Lorentz Force

Let's review how electricity is generated and why external work or energy should be supplied to generate the electric energy in a simple case as shown in Fig. (1). Let's say, magnetic field induction $\vec{B}$ is uniform and the direction is going into the figure. The brown colored conducting sliding bar is moving with a constant velocity $\vec{\upsilon}$.

First, let us consider loop 1 including V1 (VOM) and the sliding bar. The magnetic flux change rate, $\frac{d\Phi}{dt} = +B\upsilon L$ (clockwise direction), and electromotive force (emf), $\mathcal{E} = -B\upsilon L$. Hence, V1 (VOM) should indicate $B\upsilon L$ (Volts). Now, let us think the other loop 2 including V2 (VOM) and the sliding bar. The magnetic flux change rate $\frac{d\Phi}{dt} = -B\upsilon L$ (clockwise direction), and emf $\mathcal{E} = +B\upsilon L$. Therefore, V2 should indicate $B\upsilon L$ too.

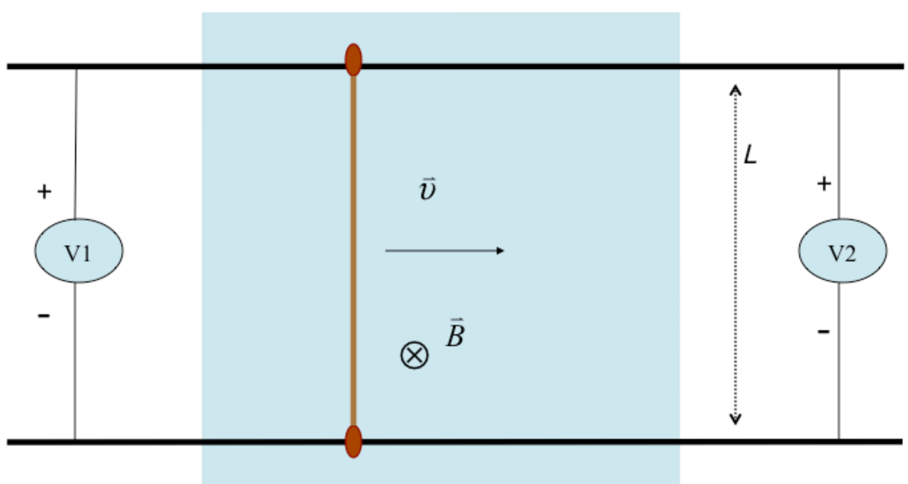

Fig. 1

Now, let us consider that the motion of charge carriers in the sliding bar with Lorentz force to estimate the emf $\mathcal{E}$. If the sliding bar is moving with the velocity $\vec{\upsilon}$ under the influence of magnetic field $\vec{B}$, electric field is created as $\vec{E} = \vec{\upsilon} \times \vec{B}$ for the moving charge carriers, and total emf on the sliding bar,

$$\mathcal{E} = \left| \int_{down}^{up} \left(\vec{\upsilon} \times \vec{B} \right) \cdot d\vec{l} \right| = B\upsilon L$$

as expected. If current I is flowing through the sliding bar as in the Fig. (2), $I = 2.0\frac{B\upsilon L}{R}$, in which L is length of the sliding bar and R is electrical resistance. Now, the current I produces a magnetic field induction of which the directions are coming out of the figure in left hand side (LHS) of the sliding bar and going into the figure in right hand side (RHS) of the sliding bar. To keep the sliding bar moving with velocity $\vec{\upsilon}$ an external force should be applied against the force exerted on the sliding bar as

$$\vec{F} = I \int_{down}^{top} d\vec{l} \times \vec{B} \qquad \text{(to the Left).} \tag{1}$$

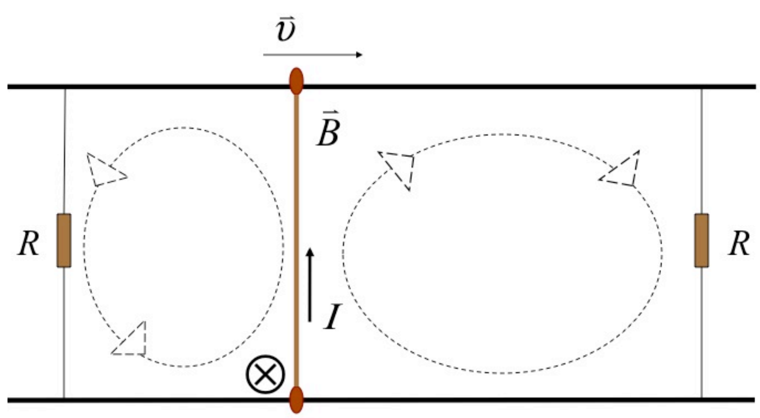

Fig. 2

Therefore, the external force $\vec{F}_{ext} = ILB$ pointing to RHS in Fig. (2), and to generate the current I in the circuit the work is needed as followings:

$$\begin{aligned}\frac{dW}{dt} &= \vec{F}_{ext} \cdot \vec{\upsilon} \\ &= IB\upsilon L \\ &= I\,\mathcal{E} \\ &= I^2 \times R_{eq} \text{ (Watt)},\end{aligned}$$

in which $R_{eq} = \frac{R}{2}$. Hence, energy conservation law in physics is satisfied. Now, let us analyze the circuit again with Lorentz force law. The current in the sliding bar can be expressed as $I = s\rho\upsilon_d$ (s is cross-section area; ρ, charge density; υ_d, drift velocity). If charge carriers are moving upward with velocity υ_d, once again Lorentz force is exerted on the moving charge carriers. The net force exerting on the sliding bar,

$$\begin{aligned}\vec{F} &= s\rho L\upsilon_d B \quad \text{(to the Left)} \\ &= ILB\end{aligned}$$

as shown in the Eqn. (1) using Faraday's law of induction. As shown above, if the magnetic field induction is not time dependent and its flux change is accompanied with movements in a closed circuit, we can simply say that Faraday's law of induction is macroscopic expression and Lorentz force is microscopic expression to explain how emf is induced in the circuit because Faraday's law of induction is derivable from Lorentz force and vice versa. However, for the mechanism of homopolar generator, which also has been known as Faraday disk, Faraday's law of induction cannot explain the emf induced between the center and the edge of the disk since there is no magnetic flux change involved, but Lorentz force law can explain it – Faraday paradox (Ricker). Once the ontological reality of magnetic field is figured out (Kim 2017), whether or not the line of magnetic field is rotating together with magnet (source of magnetic field) cannot be a question anymore. In addition, the common physical foundation for both physical laws, Faraday's law of induction and Lorentz force, can be confirmed even though they seem to appear differently in phenomena.

Shown as above, the mechanical force must be applied against the backward force that is being generated while the generated electric current is flowing in the sliding bar; hence, as the electrical energy produced, the same amount of mechanical energy is supplied, which means that the conservation of energy is valid. However, if there is any way with which external energy (mechanical work) is not needed to produce electricity, it should be interesting because it is free electric energy in reality. Then, it needs to be investigated how it is possible and why the law of energy conservation is not valid.

Moving Sliding Bar but Slanted

What if the sliding bar in Fig. (1) is slanted as shown in Fig. (3)? Let's assume that charge carrier q is electron $\left(q=-e<0\right)$; thus, moving upward through the sliding bar. The Lorentz force acting on each charge carrier in the sliding bar, $\vec{F}=-e\left(\vec{\upsilon}\times\vec{B}\right) \Rightarrow e\upsilon B\left(\vec{j}\right)$, in which magnetic field $\vec{B}$ is coming out of figure. Since the charge carriers can move in the sliding bar, only the force $\vec{f}_s$ contributes the drifting velocity $\vec{\upsilon}_d$.

If the drift velocity is given as $\upsilon_d=\mu_e E\cos\left(\theta\right)$, in which μ_e is electron mobility and $E=V_{eff}B$ where $V_{eff}\equiv\upsilon-\upsilon_d\sin\left(\theta\right)$; then,

$$\upsilon_d=\frac{\mu_e B\upsilon\cos\left(\theta\right)}{\left[1+\mu_e B\sin\left(\theta\right)\cos\left(\theta\right)\right]},$$

and backward force, f_b, exerted on each charge carrier in the sliding bar moving with velocity υ is expressed as

$$\vec{f}_b=e\mu_e V_{eff}B^2\cos\left(\theta\right)\left(-\frac{\vec{f}_r}{f_r}\right),\text{ in which }\theta>0.$$

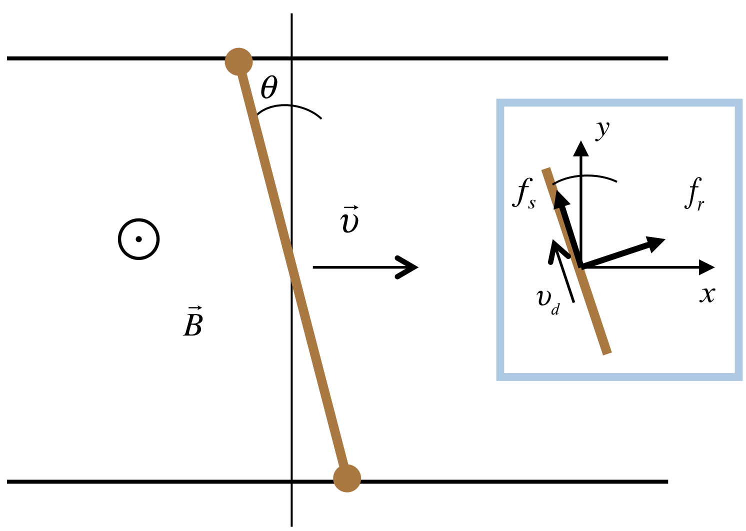

Fig. 3

If f_b is smaller than or equal to the f_r, which is also exerted on each moving charge carrier as $f_r = eV_{eff}B\sin(\theta)$, do we need the external force as shown in Eqn. (1), which is to maintain the velocity υ and results in external work supplied to generate electric currents?

The condition for $f_b \le f_r$ is $\mu_e B \le \tan(\theta)$. Hence, the critical angle for the condition,

$$\theta \ge \theta_{crit}, \text{ in which } \theta_{crit} \equiv \tan^{-1}(\mu_e B). \tag{2}$$

It is dependent of magnetic field induction $(\vec{B})$ and intrinsic material properties, such as electrical conductivity σ, electron #density n_e since $\mu_e = \dfrac{\sigma}{n_e e}$, but independent of the velocity υ. For example, if the sliding bar is made of copper, the mobility of electron $\mu_e \sim 4.5\times10^{-3}\left(\text{m}^2\text{V}^{-1}\text{s}^{-1}\right)$; thus, for the condition of Eqn. (2) if $B \sim 1\text{T}$, the critical angle $\theta_{crit} \sim 0.26^\circ$. It is a small angle but positive, though.

If the θ is adjusted as in Eq. (2) and the generated current is flowing in the slanted sliding bar, the velocity υ can be increased by itself because $f_b \le f_r$. Literally, it is free electric energy. Then, the question is where the extra energy is coming from.

Faraday Disk (Homopolar Generator)

If a conducting disk is rotating under the influence of magnetic field $\vec{B}$ as shown in Fig. (4), electromotive force (emf) is induced in radial direction. In Fig. (4), the direction of background magnetic field is coming out of the figure; the conducting disk is rotating in clockwise direction; due to the emf, electrons move from the inner edge at radius r to the outer edge at radius R of conducting disk; a couple of possible electron paths are shown with red lines. Now, the question is whether or not the movement of these electrons generates a backward torque because an external work should be supplied to maintain the rotating velocity against the backward torque.

First of all, let's review what is the electric current in a conducting wire or metal in general. Under the influence of electric field, the electron (electrons) in outmost shell of metal atom (valence electron) can be detached and move easily to nearby positive atomic ion. These electrons are known as free electrons and generate the electric current in the conducting wire or metal. After being detached from a neutral atom the free electron gains a kinetic momentum and transfers the momentum to another positive atomic ion when the ion recaptures it. However, the positive atomic ion is also expected to gain some amount of kinetic momentum but in reverse direction of electron's movement. Then, these kinetic momentums of positive atomic ion and electron are transferred to system when positive atomic ion recaptures electron; hence, net momentum transfer into the system body should be zero.

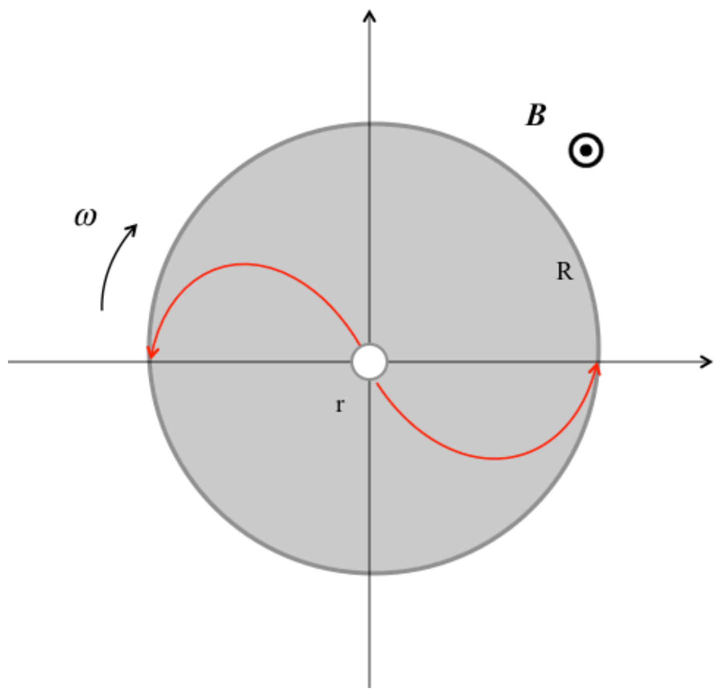

Fig. 4

In Fig. (4), however, the Lorentz force acting on moving charges is not in the same direction but perpendicular to the direction of charge moving. Also, the positive atomic ions are almost fixed in the rotating disk frame; hence, the direction of Lorentz force on the positive ions is only in radial direction. Therefore, the momentum component of electron in inverse rotating direction is naturally expected, which is shown with red lines in Fig. (4), and it should be transferred to the rotating disk body when the electron is recaptured to the positive atomic ion. Hence, the backward torque is produced in the rotating disk, and some external work needs to be supplied to overcome the backward torque.

However, with the simple relation of mechanical work and force, let's consider whether the conservation of energy is valid in homopolar generator. If the electrons are making paths similar to the red lines in Fig. (4) in a frame fixed on the rotating disk, the backward torque produced in the rotating disk should be smaller than the one expected for the conservation of energy. It means that output electric energy can be greater than input energy done by mechanical work, which is called over-unity efficiency. The over-unity efficiency of homopolar generator or, simply, free electric energy generator already has been issued by pioneering researchers, such as Nikola Tesla (Tesla 1981, Nichelson), Bruce E. DePalma

(DePalma 2018, DePalma 2003, DePalma, Kincheloe 1986), Paramahamsa Tewari (Tewari), and more.

Now, if the conducting disk is made to have the slanted effect for electric current passage as shown in Fig. (3); then, the backward torque will be disappeared, and the external work is not needed any more. In fact, as shown in Fig. (5), the slanted effect on the rotating disk should be made in a spiral pattern as $r(\theta) \leq r_0 e^{\beta(\theta-\theta_0)}$, in which $\beta \equiv \cot(\theta_c)$ for $\theta_c \geq \theta_{crit}$ in Eq. (2) and (r_0, θ_0) is the initial position for each charge carrier (electron) in polar coordinate system. It is free electric energy generation, indeed.

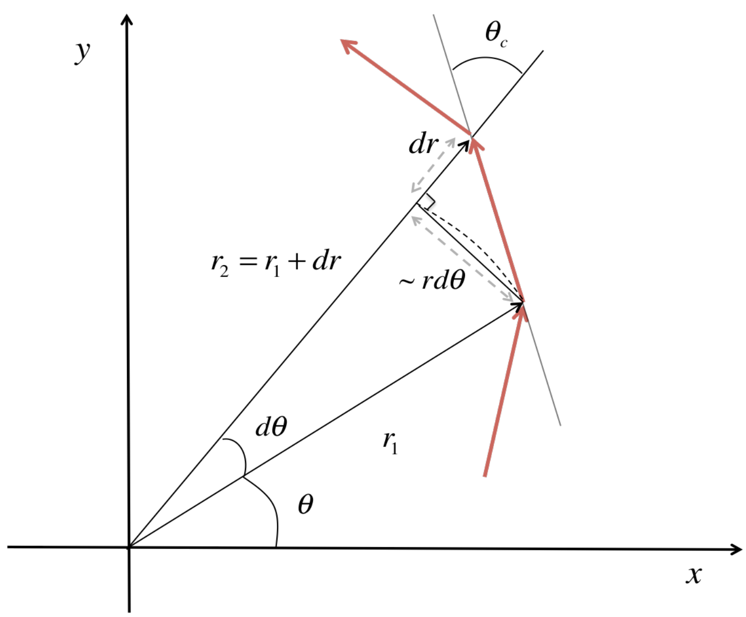

Fig. 5

Furthermore, there is a quite interesting fact that is found in the review of their works: The spiral pattern of current passage on rotating disk already had been mentioned (Tesla 1981, DePalma 2003, Thomas Valone 1994) as a way to generate free electric energy or to improve the performance of homopolar generator; however, the theoretical explanations or interpretations for the spirally-segmenting[2] method in their works were different from the explanation given as above. Also, it is not clear how thoroughly the effect of spirally-segmenting method has been investigated in experiments.

[2] spirally subdividing the disk (Tesla, 1981).

Magnetic Flux Variations with a Permanent Magnet

In a closed loop of wire, for instance, if magnetic flux is changed, an electromotive force (emf) is induced and an electric current is generated through the loop of wire; then, the electric current produces magnetic field against the variation of magnetic flux; hence, usually external energy (mechanical work, electric energy, or magnetic field energy) is needed to maintain the variation of magnetic flux or to restore the magnetic flux used up to generate the electric current in the loop of wire. Then, what if the intensity of magnetic field is constant over time as in a permanent magnet? Do we still need the external energy to restore the magnetic flux?

From previous sections, in which we confirmed the possibility of free electric energy generation, we realize an important fact about the magnetic field $\vec{B}$ that was constant over time although we didn't mention it clearly. What if a permanent magnet can be used to mediate the magnetic flux variation to induce the emf and generate the electric current? Then, how the electrical input energy is related to the output energy?

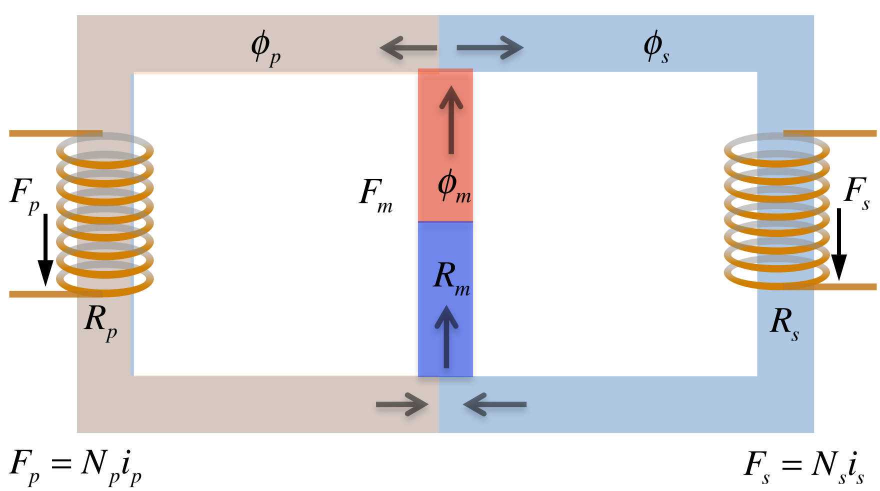

Fig. 6

In Fig. (6), a schematic drawing of magnetic circuit is shown, in which a primary coil of wire and a secondary coil of wire are shown with magnetomotive force (mmf) F_p and F_s, respectively. In addition, F_m is mmf; ϕ_m, magnetic flux; R_m, magnetic reluctance in the equivalent magnetic circuit for the permanent magnet, in which the relative magnetic permeability $\left(\mu_r\right)$ is close to 1.0 as in the air[3].

In the figure, magnetic flux ϕ_p is passing through the LHS (left hand side) of magnetic circuit in which magnetic reluctance is R_p; magnetic flux ϕ_s is passing through the RHS (right hand side) of magnetic circuit in which magnetic reluctance is R_s.

If the permanent magnet is not inserted in the magnetic circuit, $\phi_p = -\phi_s$ and $\phi_p = \dfrac{F_p - F_s}{R_p + R_s}$; in root-mean-square (rms) time average for a sinusoidal steady state, $\left\langle F_p \right\rangle = \left\langle F_s \right\rangle$ and $\left\langle \phi_p \right\rangle = \left\langle \phi_s \right\rangle = 0$ as expected in an ideal case without any energy loss, such as eddy current loss, hysteresis loss of magnetic core, joule heating in the circuit, etc. For instance, if the primary AC current (i_p) generates magnetic flux (ϕ_p) from which an emf is induced in the secondary coil as $\mathcal{E}_s = -M_{(p\to s)}\dfrac{di_p}{dt}$, in which $M_{(p\to s)}$ is mutual inductance from primary coil to secondary coil; thus, a secondary current (i_s) is generated. Then, the secondary current generates magnetic flux (ϕ_s) that induces emf in the primary coil as $\mathcal{E}_p = -M_{(s\to p)}\dfrac{di_s}{dt}$. At this time, the emf induced in the primary coil is not an energy source but an energy sink for the primary coil letting more current flow to compensate the magnetic field energy used up to generate current in the secondary coil. Here, the mutual inductance depends on only the circuit geometry; thus, $M_{(p\to s)} = M_{(s\to p)}$. If a constant electric energy (in time average) is coming into the primary coil and going out through the secondary coil without any energy loss, $\left\langle F_p \right\rangle = \left\langle F_s \right\rangle$ since $N_p \propto V_p$ and $N_s \propto V_s$, respectively.

Now, with the permanent magnet shown in Fig. (6) the magnetic circuit can be analyzed as in an electrical circuit using Kirchhoff's law. Since magnetic flux should be conserved at each node, $\phi_m = \phi_p + \phi_s$; $F_p + F_m = \phi_m R_m + \phi_p R_p$ for the LHS loop including permanent magnet; and $F_s + F_m = \phi_m R_m + \phi_s R_s$ for the RHS loop including permanent magnet.

$$
\begin{aligned}
F_p + F_m &= \left(\phi_p + \phi_s\right) R_m + \phi_p R_p \\
&= \phi_p \left(R_m + R_p\right) + \phi_s R_m
\end{aligned}
\tag{3}
$$

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[3] magnetic reluctance $R = \dfrac{l}{\mu_0 \mu_r A}$.

and

$$\begin{aligned} F_s + F_m &= \left(\phi_p + \phi_s\right) R_m + \phi_s R_s \\ &= \phi_s \left(R_m + R_s\right) + \phi_p R_m. \end{aligned} \tag{4}$$

In a matrix form, which is

$$\begin{pmatrix} R_m + R_p & R_m \\ R_m & R_m + R_s \end{pmatrix} \begin{pmatrix} \phi_p \\ \phi_s \end{pmatrix} = \begin{pmatrix} F_p + F_m \\ F_s + F_m \end{pmatrix}.$$

Therefore,

$$\phi_p = \frac{\begin{vmatrix} F_p + F_m & R_m \\ F_s + F_m & R_m + R_s \end{vmatrix}}{\begin{vmatrix} R_m + R_p & R_m \\ R_m & R_m + R_s \end{vmatrix}} = \frac{F_p\left(R_m + R_s\right) + F_m R_s - F_s R_m}{\left(R_p + R_s\right) R_m + R_p R_s}, \tag{5}$$

$$\phi_s = \frac{\begin{vmatrix} R_m + R_p & F_p + F_m \\ R_m & F_s + F_m \end{vmatrix}}{\begin{vmatrix} R_m + R_p & R_m \\ R_m & R_m + R_s \end{vmatrix}} = \frac{F_s\left(R_m + R_p\right) + F_m R_p - F_p R_m}{\left(R_p + R_s\right) R_m + R_p R_s}. \tag{6}$$

However,

$$\begin{aligned} \phi_m &= \phi_p + \phi_s \\ &= \frac{F_m\left(R_p + R_s\right) + F_p R_s + F_s R_p}{\left(R_p + R_s\right) R_m + R_p R_s}. \end{aligned} \tag{7}$$

If the magnetomotive force (mmf) or magnetomotance F_p and F_s are absent in Eqn. (7), $\phi_m = \frac{F_m}{R_t}$, in which $R_t = R_m + \frac{R_p R_s}{R_p + R_s}$, $\phi_s = \phi_m \cdot \frac{R_p}{R_p + R_s}$ in Eqn. (6), and $\phi_p = \phi_m \cdot \frac{R_s}{R_p + R_s}$ in

Eqn. (5) as expected. If $R \equiv R_p = R_s$ to make it more simple, $R_t = R_m + \frac{R}{2}$ and $\phi_p = \phi_s = \frac{\phi_m}{2}$. From Eqn. (7), if $F_p \neq 0$ and $F_s \neq 0$ but $R_p = R_s$; then, $\phi_m = \frac{2F_m + F_p + F_s}{2R_m + R}$, which cannot be constant over time if $F_p + F_s \neq 0$. By the way, as long as mmf F_p or F_s is given as $\left(F_{p \text{ or } s}\right)_{\max} \leq \phi_m R_{p \text{ or } s}$; then, $F_{p \text{ or } s} << F_m$ since $R_{p \text{ or } s} << R_m$ in general; thus, ϕ_m is almost constant.

However, the proposition as ϕ_m is constant over time, it should be acceptable for permanent magnets because the magnetic field of a permanent magnet is supposed to be constant over time. Therefore, let's assume that

$$F_p R_s + F_s R_p = 0 \tag{8}$$

in Eqn. (7).

From Eqn. (5) and Eqn. (6), if both, F_p and F_s, are not zero,

$$\Delta\phi_p = \frac{\left(F_p - F_s\right)R_m - F_p R_s}{\left(R_p + R_s\right)R_m + R_p R_s}, \tag{9}$$

and

$$\Delta\phi_s = \frac{\left(F_s - F_p\right)R_m - F_s R_p}{\left(R_p + R_s\right)R_m + R_p R_s}. \tag{10}$$

If the permanent magnet is absent in Fig. (6), which is equivalent to the case of $R_m \to \infty$, for the time average of the sinusoidal steady state, $\Delta\phi_p = \Delta\phi_s = 0$ and $F_p = F_s$ as long as any external energy source or sink is not involved as mentioned before. The energy conservation is valid as $i_p V_p = i_s V_s$ because $\frac{N_s}{N_p} = \frac{V_s}{V_p}$. However, with the permanent magnet included in the circuit, $\Delta\phi_p + \Delta\phi_s = 0$ because ϕ_m is assumed as a constant over time with the condition as $F_p R_s + F_s R_p = 0$ in Eqn. (8), in which the positive sign indicates that the direction of current generated is different as shown in the Fig. (6). In other words, the inductively generated mmf F_s can be greater or less than mmf F_p depending on the ratio of R_s to R_p.

In a sinusoidal steady state, in which electric energy keeps coming into the primary coil and going out through the secondary coil, the variation of magnetic flux $\left|\Delta\phi_p\right| = \left|\Delta\phi_s\right|$ in Eqn. (9) and Eqn. (10) with the condition in Eqn. (8).

In the meanwhile, $V_p \propto N_p \Delta\phi_p \propto M_{(s\to p)} \dfrac{di_s}{dt}$ and $V_s \propto N_s \Delta\phi_s \propto M_{(p\to s)} \dfrac{di_p}{dt}$; then, mutual inductance $M_{(s\to p)} \propto R_p$ and $M_{(p\to s)} \propto R_s$ because $\left|\Delta\phi_p\right| = \left|\Delta\phi_s\right|$. Now, if the mutual inductances are not symmetry as $M_{(p\to s)} \neq M_{(s\to p)}$, the output power in a steady state can be different from input power as following: the emf induced in the secondary coil $V_s \propto R_s i_p$ since $M_{(p\to s)} \propto R_s$ and $\dfrac{di_p}{dt} \propto i_p$; the emf induced in primary coil $V_p \propto R_p i_s$ since $M_{(s\to p)} \propto R_p$ and $\dfrac{di_s}{dt} \propto i_s$ for the system in a sinusoidal steady state. Since $N_p i_p R_s = N_s i_s R_p$ from Eqn. (8), the ratio of voltages and the ratio of currents are expected as

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \quad \text{and} \quad \frac{i_s}{i_p} = \frac{N_p R_s}{N_s R_p}, \tag{11}$$

respectively. Then, the output power ratio to input power is

$$\frac{W_s}{W_p} = \frac{i_s V_s}{i_p V_p} = \frac{R_s}{R_p}. \tag{12}$$

It can be a typical transformer but including a permanent magnet: electric energy is transferred by means of magnetic flux variations; input electric energy is transformed to magnetic field energy; the magnetic field energy is transformed to the output electric energy. However, magnetic flux of the permanent magnet gets involved in the process of magnetic flux variations, which induce the electromotive force (emf) and generate electric currents in the secondary coil and the primary coil, and takes over the process of magnetic flux variation. Now, the questions are why the conservation of energy cannot be valid and where the extra energy is coming from if $R_s > R_P$.

Using the static magnetic field of a permanent magnet(s) and its interaction with variable magnetic fields, so called, Motionless Electromagnetic Generator (MEG), there have been many similar researches (Bearden, JNL Labs, collective-evolution.com, wanttoknow.info, etc.) and patents (Rivas 1977, Richardson 1978, Asaoka 1999, Flynn 2001, Patrick, et al. 2002, etc.). Although those researches and patents can be distinguished from one another in the generating methods and the device structures, there is a common fact that a permanent magnet (or magnets) is used in the devices. Again, the question is what is the crucial function of permanent magnet in MEG, which is called over-unity device.

Summary and Discussion

Michael Faraday, who discovered electromagnetic induction by himself, should have wondered how the electromotive force (emf) still occur when the permanent magnet is rotating together with the conducting disk in his homopolar experiment, which has been called Faraday's paradox with some other cases in which Faraday's law of induction is seemingly inconsistent. Now, we can explain for that question and other cases as well: A permanent magnet and its magnetic field are not in the same space in 4-D complex space; the permanent magnet is a physical object in real space that makes a static current effect for vacuum particles in imaginary space; on the other hand, its magnetic fields, which is a manifestation of vacuum particles spontaneously realigning their spins against the current effect made by permanent magnet, can be realized through physical interactions in phenomena. Moreover, the interaction between electric field and magnetic field should be presumed when Faraday's law of induction is applied.

Once a ferromagnetic material is magnetized, it preserves its magnetic field unless demagnetized by an external enforcement on purpose, such as applying a strong reverse magnetic field, heating above Curie temperature, etc; thus, it is so-called permanent magnet. Hence, it can be interpreted that permanent magnet is making a current effect in physical vacuum space and the current effect is static and intrinsic property of permanent magnet, which means that the magnetic field of permanent magnet can be reinstated by itself in phenomenology.

If a permanent magnet is combined in a magnetic circuit with a primary coil for electric energy input and a secondary coil for output, for example, as shown in Fig. (6), the static flux of permanent magnet is distributed in the circuit; however, the static flux distribution can be varied when diverted by a variable magnetic flux coming from the primary coil; then, due to the flux variation of permanent magnet, an electromotive force (emf) is induced in the secondary coil and an electric current is generated by the delegating magnetic fields of permanent magnet. Now, the current in the secondary coil generates a magnetic flux to divert the flux distribution of permanent magnet again; the flux variation of permanent magnet induces an emf in the primary coil, which results in more electric currents pulling from the source, and which produces magnetic flux in the circuit to make up some of magnetic flux used for the current generation in the secondary coil. At the same time, the flux of permanent magnet is restored[4] by itself since the magnetic flux variations in the primary and the secondary coils are made through the delegating magnetic fields coming out of the permanent magnet and the current effect of permanent magnet is static, which means that vacuum particles realign their spins spontaneously against the current effect in physical vacuum space. In other words, free electric energy is generated out of physical vacuum space. By the same token, the extra energy produced in the homopolar generator with and without the slanted effect (pp. 8) is also coming from physical vacuum

[4] Tom Bearden used 'replenish'.

space because the magnetic field of permanent magnet works and its magnetic field is reinstated by itself.

In short, the permanent magnet can be a free energy portal in physical vacuum space, through which magnetic field energy is transferred between the physical vacuum and the system, which means that the law of conservation of energy is not valid any more because the system is not isolated but connected to the physical vacuum space.

If we believe that all of natural phenomena should be confined only in phenomenological world, intuitively it is natural for us to think that nothing can be created from nothing. Nevertheless, even before the last century, over-unity electromagnetic device or free energy generator using a permanent magnet(s) has been issued on its feasibility despite the fact that conventional law of conservation of energy is violated. If the free energy device becomes a reality as being suggested from many pioneering researches (Kelly), the law of conservation of energy, the first principle in physics, needs to be reconsidered; then, obviously, new scientific paradigm is indispensable to understand what the physical vacuum is and how it is interacting with physical phenomena.

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