A novel concept for a non-Newtonian electromagnetic space-drive

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Abstract— a novel space-drive (thruster) concept which may provide a usable vectored thrust from simple coil geometry. We offer the concept of such a thruster based on an electromagnetic interaction retardation effect. This thruster does not rely on a conventional action-reaction propulsion system, but on a novel application of electromagnetic force.

1. Introduction

Traditional state of rocket technology only allows for thrusters that are based on the action-reaction principle. Such technology exhibits many disadvantages when applied to interplanetary or interstellar missions. Recent research by R.J. Shawyer [1] may offer a new technology that is not based on the action-reaction principle. Despite experimental evidence of the presence of a non-compensated EM force, there are members of the scientific community who are not fully convinced of the validity of such an approach. Those who object believe that the non-compensated EM force must violate Newton's 3rd law when applied to a system used to create vectored thrust. We believe, however, that while Newton's 3rd law is key to understanding classic mechanics, it is not relevant when applied to our proposed EM thruster. Reputable scientists have proposed thought experiments yielding an anomalous deviation of Newton's third law[1]. According to Page and Adams [2], the 'classical principle' of action-reaction' may not hold true in electrodynamics; instead the law of the total momentum conservation is applicable and supersedes the principle of the action-reaction. The authors also show that despite the common understanding that such a non-compensated force can act in certain electrodynamic systems, the vector of this force produces rotational motion (because the charges creating this non-compensated force move in closed orbits) so the effect of action of this force on the system does not lead to any motion of the center-of-mass of the latter.

In the expression for the non-compensated force given in [2], the authors offer an explanation of this violation of Newton's 3rd law. The suggested causality is the electromagnetic retardation effect which suggests that the electromagnetic interac-

[1] See, for example, In the Feynman Lectures on Physics. Vol. 2 Electrodynamics. Ch. 26-2, Fig. 26-6 where the author describes a paradox where the forces between two moving charges are not always equal and opposite. This suggests that 'action' is not always equal to 'reaction'.

tion propagates with a high but finite speed. Thus the principle of action-reaction is abstractly fulfilled. The authors propose that such a design for a thruster wherein the non-compensated force exerts a vector force potential without classic reaction. During this period of time, the apparatus performs one-directional motion. A thorough analysis of such electromagnetic thruster design is given in [3]. We note that McDonald concurs with the conclusion of Page and Adams in that the rotational motion of the vector of the non-compensated force does not lead to one-directional motion of the system as a whole. To overcome this inconsistency we suggest a solution as to why the non-compensated force appears in such a closed system. To do it, let us consider the simplest case of two opposite charges, one of these charges being positive, is affixed to the center of the rotation of negative charge. If the orbit of rotation is rectilinear, that is to say circular, and with the velocity of the negative charge being constant, its E field at the center of the orbit can be calculated in the closed form. We show that the motion of such a charge leads to an imbalance between forces created by the geometry of such charges.

2. Force in a system with two charges

If the velocity of the charge circulating in the orbit of radius R satisfies the condition $v \ll c$, where c is the speed of light, its E field at a center of the orbit can be found from the Darwin Lagrangian (see, for example, Eq. (3) of [2])

(1) $$\boldsymbol{E} = -\frac{q\boldsymbol{n}}{R^2} - \frac{q}{2c^2R}\left[\boldsymbol{a} + (\boldsymbol{a}\cdot\boldsymbol{n})\boldsymbol{n} + \frac{3(\boldsymbol{v}\cdot\boldsymbol{n}) - v^2}{R}\boldsymbol{n}\right]$$

where $\boldsymbol{n} = \boldsymbol{R}/R$. Because the acceleration $\boldsymbol{a}$ of the rotating charge is $a = v^2/R$, and $(\mathbf{a} \cdot \mathbf{n}) = a$, $(\mathbf{v} \cdot \mathbf{n}) = 0$, one obtains from Eq. (1)

(2) $$\boldsymbol{E} = -\frac{q\boldsymbol{n}}{R^2}\left(1 - \frac{v^2}{2c^2}\right) \ ; \quad \boldsymbol{F}_1 = -\frac{q^2\boldsymbol{n}}{R^2}\left(1 - \frac{v^2}{2c^2}\right)$$

The positive charge acts on the negative charge with the force

(3) $$\boldsymbol{F}_2 = \frac{q^2\boldsymbol{n}}{R^2}$$

so the non-compensated force between two charges is

(4) $$\Delta\boldsymbol{F} = \boldsymbol{F}_1 + \boldsymbol{F}_2 = \frac{q^2v^2\boldsymbol{n}}{2c^2R^2}$$

We should clarify one aspect of the seeming controversy with the law of conservation of the total momentum. As it is shown in [4], this law in a form

(5) $$\boldsymbol{F}_{total} + \frac{d}{dt}\boldsymbol{P}_{EM} = \frac{d}{dt}\left(\boldsymbol{P}_{mech} + \boldsymbol{P}_{EM}\right) = 0$$

where $\boldsymbol{P}_{EM}$ and $\boldsymbol{P}_{mech}$ are the electromagnetic and mechanical momenta of the system, is completely fulfilled. Similar result is obtained by McDonald (eq. (30) of [3]), namely, the center-of-mass of the closed system performs a periodic motion but with an extremely small amplitude. So we conclude that the presence of non-compensated mechanical force is due to the retardation effect but not due to breaking the law of the momentum conservation.

Because the negative charge moves in the circular (closed) orbit, the non-compensated force does not lead to the unidirectional motion of the system. But some slight modification of the system geometry may lead to the appearance of a non-compensated force. It follows from Eq. (4) that if the distance between the charges change, as occurs when one charge passes another, some amount of non-compensated force will appear.

One can see (Fig. 1) that if the charge passes the first one-half of its orbit along the circle of radius R_1 and the second one-half of its orbit along the circle of radius R_2 and the velocity of the charge is constant in the whole path, the difference between the x components of the force calculated as the integral over the angular component is

$$\Delta F_X = \int_0^{\pi} \frac{q^2 v^2 \sin\theta}{2c^2}\left[\frac{1}{R_1^2} - \frac{1}{R_2^2}\right] d\theta = \frac{q^2 v^2}{c^2} \cdot \left[\frac{1}{R_1^2} - \frac{1}{R_2^2}\right] \tag{6}$$

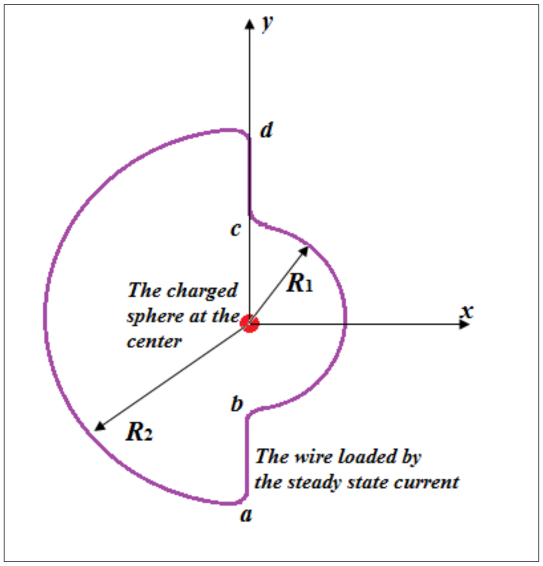
where θ is the angle between the *x* axis and the normal vector of the *E* field of the moving charge.

Actually this type of motion cannot be produced, but instead of a charge, we are able to utilize current flowing through a conductor having a special geometry. The geometry of the conductor can be chosen in such a way that the electrons of conductivity pass the first one-half of the path in the circle of radius R_1 and the second one-half in the circle of radius R_2.

Due to electro-neutrality of the conductor, the positive charge does not create force acting on the conductor. The magnetic force may be omitted as well, so that the only factor that should considered is the electric force acting on the fixed positive charge.

3. Stationary field current

Let us consider the circuit (Fig. 1) consisting of two semicircles of different radii R_1 and R_2 and two straight geometries connecting the semicircles. Such a shape of the circuit is chosen to simplify the calculation of the force despite the *E* field created by the current in this circuit cannot be exactly computed. The electric force created by the current is added to the positive charge at the geometric center of the circuit.



Now our task is to explain this *E* field. Each element of the circuit may be treated as an individual geometry of the conductor of the length *dl* with a flow of negative charges superimposed on a background of positive ions. We suggest that the negative charge of this individual geometry contains is $n_e dl$, where n_e is the linear concentration of electrons in the circuit.

We will consider the 'extra' *E* field, namely, the *E* field of each element of the conductor that is proportional to v^2, is removed from the Coulomb field comprised of negative electrons resulting from conductivity and a positive background comprised of ions. It should be noted that this type of the *E* field has been experimentally detected in [5].

The *E* fields of the straight geometries compensate each other because the lengths of the sections are equal and the *E* fields have opposing directions.

A circuit comprised of highly angular geometries in the curved conductor, followed by straight geometries and then semicircular geometries, should present a large effect on the total *E* field. But we can choose such radii of curvatures consisting of small arcs so that their parameters satisfy the relation:

$$E_a \approx \frac{a_a}{R_1} = E_b \approx \frac{a_b}{R_2} \quad \to \quad \frac{v^2}{\rho_a R_1} = \frac{v^2}{\rho_b R_2}$$

where ρ_a and ρ_b the curvatures of the arcs *a* and *b* (and the same should be correct for the arcs c and d), acceleration terms compensate each the other because of opposite direction of the vectors $\mathbf{a}_a$ and $\mathbf{a}_b$. The same is correct for small arcs *c* and *d*.

What we need is to calculate the fields created by semicircles. Using Eq. (6) it is easy to calculate

$$(7) \qquad F_{total} = \frac{Q n_e v^2}{2c^2} \int_0^{\pi} \frac{\sin\theta d\theta}{R_1^2} - \frac{Q n_e v^2}{2c^2} \int_0^{\pi} \frac{\sin\theta d\theta}{R_2^2}$$

where Q is the magnitude of the positive charge fixed in the center. Because $n_e \cdot v = I$, we have

(8) $$F_{total} = \frac{QIv}{c^2} \cdot \frac{R_2 - R_1}{R_1 R_2}$$

The estimate of this force for $Q = 10^{-6}$ Coulomb, $I = 10$ A, $v \approx 1$ mm/sec in the perfect conductor, $R_1 = 0.1$ meter and $R_2 = 1$ meter gives $F_{total} \approx 10^{-14}$ Newtons, is too weak to be detected by modern measurement devices. But the aim of this article is to show only the possibility that such a force created using only current flow through a coil of special geometry. We would also like to suggest the possibility that by combining the force of many drive coil winding of this special geometry into a single space-drive, such an engine should produce sufficient thrust to be useful in many applications from satellite station-keeping to a reliable thruster for interplanetary or even interstellar travel.

Conclusions

We suggest that should our EM space drive be constructed, that the material used for the drive coils of special geometry should be capable of withstanding extremely large current pulses necessary to produce acceptable thrust. To achieve the required thrust, the most important engineering task would be to design a system that will increase the magnitude of the non-compensated force using drive coils of special geometry. Due to the electromagnetic nature of the non-compensated force, thrust velocities could be near or at the speed of light. Of the two conventional fields which have the greatest known effect on the operation of the universe, gravitation and electromagnetism, humans are currently only capable of controlling electromagnetism in a major way. There are those who postulate that electromagnetic fields may flatten and stiffen the fabric of space-time. Should this tendency be real our EM thruster could very well be the genesis of a new paradigm in spacecraft propulsion whereby such stiffening could be used to warp the fabric of space-time in a way that could possibly allow for faster than light propulsion systems.

References

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