Conical Capacitor as Gravity Propulsion Device

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Abstract

It was proposed gravity propulsion method by using asymmetric conical capacitor charged by high voltage. It was used linear approximation of general relativity equations for derivation of gravity field potential of charged conical capacitor and was shown that negative gravity capabilities of conical capacitor depends only on ratio of electric energy and capacitor mass density, where electric energy density depends on applied voltage and geometric parameters of conical capacitor.

1 Introduction

Still in 1928 Brown patented apparatus generating propulsion by using of electric field (Brown, 1928), this effect is known as a Biefeld-Brown effect. By late 1915, Einstein published his general theory of relativity in the form in which it is used today (Einstein, 1916) but explanation of Biefeld-Brown effect was not included into equations of GR. Two years later Levi-Civita (Levi-Civita, 1917) proposed that each field energy curves gravity space-time. In 1999, Thomas L. Mahood, Woodward's graduate student from 1997 to 1999, reported thrusts ranging from 0.03 to 15 μN in a setup comprising a torque pendulum in a vacuum chamber, at the Space Technology and Applications International Forum (STAIF) (Mahood, 2000).

Other group of physical experiments of gravity motion was investigated by using GHz frequency electromagnetic field. Radio frequency resonant cavity thrusters in particular have been promoted by two inventors who say they have designed such devices: Roger Shawyer designed a thruster he called the EmDrive (Shawyer, 2004), and Guido Fetta designed a thruster he called the Cannae Drive (Fetta, 2014). Thus, physicists have tried to build and test their own resonant cavity thrusters, based on the designs published by Shawyer and Fetta. Sonny White's group at NASA's Eagleworks laboratories, which tests unusual rocket designs, has built and tested versions of both the EmDrive and the Cannae drive. In late 2016, a peer-reviewed paper by the same group was published that found a consistent thrust-to-power ratio of $1.2 \pm 0.1 mN/kW$. (White et al., 2016).

All above mentioned physical experiments have one similar behaviour property of motion by impact of electromagnetic field. Therefore, theoretical explanation of this effects as proposed Levi-Civita can be based on gravity space-time curved by an electromagnetic field (Maknickas, 2013). Aim of this article is the theoretical investigation of propulsion capabilities of charged conical capacitor by derivation of gravity field potential of this device.

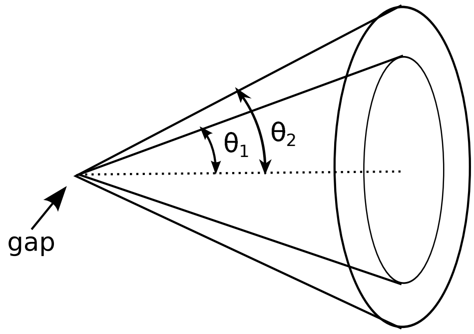

Figure 1: Two cones with small gap at zero

2 Electric field of conical capacitor

Consider the coaxial cone (Sadiku, 2010) of figure Fig. 2, where the gap serves as an insulator between the two conducting cones. ϕ_g depends only on θ, so Laplace's equation in spherical coordinates becomes

$$\nabla^2 \phi_E = 0 \tag{1}$$

$$\frac{1}{r^2 \sin\theta} \frac{\partial}{\partial\theta} \left(\sin\theta \frac{\partial \phi_E}{\partial\theta} \right) = 0, \;\; R, \theta > 0 \tag{2}$$

Since $r = 0$ and $\theta = 0$, it are excluded, we can multiply by $r^2 \sin\theta$ to get after integration

$$\sin\theta \frac{\partial \phi_E}{\partial\theta} = A \tag{3}$$

Integrating twice gives

$$\phi_E = \int \frac{A d\theta}{\sin\theta} + B = A \log\left(\tan\frac{\theta}{2}\right) + B \tag{4}$$

We now apply the boundary conditions to determine the integration constants A and B

$$0 = A \log\left(\tan\frac{\theta_1}{2}\right) + B \tag{5}$$

$$V_0 = A \log\left(\tan\frac{\theta_2}{2}\right) + B \tag{6}$$

The equations eq. (5) and eq. (6) gives

$$B = -A \log\left(\tan\frac{\theta_1}{2}\right) \tag{7}$$

$$V_0 = A \log\left(\frac{\tan\frac{\theta_2}{2}}{\tan\frac{\theta_1}{2}}\right) \tag{8}$$

So, the constant A equals to

$$A = \frac{V_0}{\log\left(\dfrac{\tan\theta_2/2}{\tan\theta_1/2}\right)} \tag{9}$$

Thus

$$\phi_E = \frac{V_0 \log\left(\dfrac{\tan\theta/2}{\tan\theta_1/2}\right)}{\log\left(\dfrac{\tan\theta_2/2}{\tan\theta_1/2}\right)} \tag{10}$$

Finally, electric field of conical capacitor is

$$\mathbf{E} = -\nabla\phi_E = -\frac{1}{r}\frac{\partial\phi_E}{\partial\theta}\mathbf{a}_\theta = -\frac{V_0\mathbf{a}_\theta}{r\sin\theta\log\left(\dfrac{\tan\theta_2/2}{\tan\theta_1/2}\right)} \tag{11}$$

3 Gravity field of conical capacitor

Gravity potential inside and outside a capacitor can by found by using Maxwell equations representation of linear approximation of equation general of relativity (Mashhoon et al., 1999; Clark, Tucker, 2000)

$$\begin{aligned}
\nabla\cdot\mathbf{E}_g &= -4\pi G\rho_g && (12)\\
\nabla\cdot\mathbf{B}_g &= 0 && (13)\\
\nabla\times\mathbf{E}_g &= -\frac{\partial\mathbf{B}_g}{\partial t} && (14)\\
\nabla\times\mathbf{B}_g &= 4\left(-\frac{4\pi G}{c^2}\mathbf{J}_g + \frac{1}{c^2}\frac{\partial\mathbf{E}_g}{\partial t}\right) && (15)
\end{aligned}$$

where equation eq. (12) should by used and gravity field strength expressed as follow $\mathbf{E}_g = -\nabla\phi_g$ and gravity mass density ρ_g is substitution of pure gravity mass density and electric field energy multiplied by electro-gravity coupling constant α_g and expressed as follow (Maknickas, 2013)

$$\rho_g = \left(\rho_c - \frac{\alpha_g\varepsilon\varepsilon_0 E^2}{2}\right) \tag{16}$$

Thus, we obtain the Poisson equation for gravity field potential ϕ_g

$$\nabla^2\phi_g = -4\pi^2 G\left(\rho_c - \frac{\varepsilon\varepsilon_0\alpha_g V_0^2}{2r^2\sin^2\theta\log^2\left(\dfrac{\tan\theta_2/2}{\tan\theta_1/2}\right)}\right) \tag{17}$$

The Poisson's equation eq. (17) we will solve by using Green function

$$\begin{aligned}
G(r,\theta,\phi,\xi,\eta,\zeta) &= \frac{1}{4\pi\sqrt{r^2 - 2r\xi\cos\gamma + \xi^2}} && (18)\\
\cos\gamma &= \cos\theta\cos\eta + \sin\theta\sin\eta\cos(\phi-\zeta) && (19)
\end{aligned}$$

Using Green function method gravity potential is

$$\phi_g = \int_0^R \int_{\theta_1}^{\theta_2} \int_0^{2\pi} f_g(\xi, \eta, \zeta) G(r, \theta, \phi, \xi, \eta, \zeta) \xi^2 \sin \eta d\xi d\eta d\zeta \tag{20}$$

$$f_g = -4\pi^2 G \left(\rho_c - \frac{\varepsilon \varepsilon_0 \alpha_g V_0^2}{2r^2 \sin^2 \theta \log^2 \left(\frac{\tan \theta_2/2}{\tan \theta_1/2} \right)} \right) \tag{21}$$

and finally

$$\phi_g = -\pi G \int_0^R \int_{\theta_1}^{\theta_2} \int_0^{2\pi} \frac{\left(\rho_c \xi^2 \sin^2 \eta - a\right) d\xi d\eta d\zeta}{\sin \eta \sqrt{r^2 - 2r\xi \cos \gamma + \xi^2}} \tag{22}$$

$$a = \frac{\varepsilon \varepsilon_0 \alpha_g V_0^2}{2 \log^2 \left(\frac{\tan \theta_2/2}{\tan \theta_1/2} \right)} \tag{23}$$

4 Integration of gravity field potential

The Green function for variables x and x' can be expressed as an expansion (Arfken, 1985)

$$\frac{1}{|\mathbf{x} - \mathbf{x}'|} = \sum_{i=0}^{\infty} \frac{r_<^l}{r_>^{l+1}} P_l(\cos \gamma) \tag{24}$$

Where $r_<$ and $r_>$ are the smaller and larger of r and r', respectively, and γ is the angle between x and x'. We can align x' along the z-axis as shown in Fig. X.X. This system has azimuthal symmetry, thus we can expand the potential as

$$\frac{1}{|\mathbf{x} - \mathbf{x}'|} = \sum_{i=0}^{\infty} \frac{r_<^l}{r_>^{l+1}} P_l(\cos \theta) \tag{25}$$

where angle θ is angle between r and z-axis. Therefore, integrals reduce to the new ones

$$\int_0^R \int_{\theta_1}^{\theta_2} \int_0^{2\pi} \frac{\left(\rho_c \xi^2 \sin^2 \eta - a\right) d\xi d\eta d\zeta}{\sin \eta \sqrt{r^2 - 2r\xi \cos \gamma + \xi^2}} =$$

$$2\pi \int_0^R \int_{\theta_1}^{\theta_2} \frac{\left(\rho_c \xi^2 \sin^2 \eta - a\right) d\xi d\eta}{\sin \eta \sqrt{r^2 - 2r\xi \cos (\theta - \eta) + \xi^2}} \tag{26}$$

Now Legendre polynomial expansion eq. (24) can be applied. We are interesting in field potential outside the conic capacitor $r > \xi$, thus

$$\int_0^R \int_{\theta_1}^{\theta_2} \frac{\left(\rho_c \xi^2 \sin^2 \eta - a\right) d\xi d\eta}{\sin \eta \sqrt{r^2 - 2r\xi \cos(\theta - \eta) + \xi^2}} =$$

$$\sum_{l=0}^{\infty} \int_0^R \int_{\theta_1}^{\theta_2} \left(\rho_c \xi^2 \sin \eta - \frac{a}{\sin \eta}\right) \frac{\xi^l}{r^{l+1}} P_l(\cos(\theta - \eta)) d\xi d\eta =$$

$$\sum_{l=0}^{\infty} \left(\frac{\rho_c R^{l+3}}{(l+3) r^{l+1}} F_l^1(\theta, \theta_1, \theta_2) - \frac{a R^{l+1}}{(l+1) r^{l+1}} F_l^2(\theta, \theta_1, \theta_2) \right) \quad (27)$$

where F_l^1, F_l^2 denotes integrals

$$F_l^1(\theta, \theta_1, \theta_2) = \int_{\theta_1}^{\theta_2} \sin \eta P_l(\cos(\eta - \theta)) d\eta \quad (28)$$

$$F_l^2(\theta, \theta_1, \theta_2) = \int_{\theta_1}^{\theta_2} \frac{P_l(\cos(\eta - \theta))}{\sin \eta} d\eta \quad (29)$$

$$(30)$$

and r_ε is small, not zero gap.

The similar way field potential will be find in inside zone $r < \xi$. Thus

$$\int_0^R \int_{\theta_1}^{\theta_2} \frac{\left(\rho_c \xi^2 \sin^2 \eta - a\right) d\xi d\eta}{\sin \eta \sqrt{r^2 - 2r\xi \cos(\theta - \eta) + \xi^2}} =$$

$$\sum_{l=0}^{\infty} \int_r^R \int_{\theta_1}^{\theta_2} \left(\rho_c \xi^2 \sin \eta - \frac{a}{\sin \eta}\right) \frac{r^l}{\xi^{l+1}} P_l(\cos(\theta - \eta)) d\xi d\eta +$$

$$\sum_{l=0}^{\infty} \int_0^r \int_{\theta_1}^{\theta_2} \left(\rho_c \xi^2 \sin \eta - \frac{a}{\sin \eta}\right) \frac{\xi^l}{r^{l+1}} P_l(\cos(\theta - \eta)) d\xi d\eta =$$

$$\sum_{l=0, l \neq 2}^{\infty} \left(\frac{\rho_c \left(R^2 - r^2\right)}{(-l+2)} F_l^1(\theta, \theta_1, \theta_2) + \frac{a}{l} F_l^2(\theta, \theta_1, \theta_2) \right) + \rho_c \log \frac{R}{r} F_l^1(\theta, \theta_1, \theta_2)$$

$$\sum_{l=0}^{\infty} \left(\frac{\rho_c r^2}{(l+3)} F_l^1(\theta, \theta_1, \theta_2) - \frac{a}{(l+1)} F_l^2(\theta, \theta_1, \theta_2) \right) \quad (31)$$

5 Acceleration at the Earth surface

The gravity field function at the earth surface can be expressed with accuracy $O(\frac{1}{r^2})$ as follow

$$
\begin{aligned}
\phi_g(r) = -\frac{G}{r}\left(\frac{\pi R^3 \rho_c (\cos\theta_1 - \cos\theta_2)}{3} - \right. \\
\left. \frac{\pi a R}{2} \log \frac{(1-\cos\theta_2)(1+\cos\theta_1)}{(1-\cos\theta_1)(1+\cos\theta_2)}\right) = \\
-\frac{G}{r}\left(m - \frac{\varepsilon\varepsilon_0 \alpha_g V_0^2}{2\log^2\left(\frac{\tan\theta_2/2}{\tan\theta_1/2}\right)} \frac{\pi R}{2} \log \frac{(1-\cos\theta_2)(1+\cos\theta_1)}{(1-\cos\theta_1)(1+\cos\theta_2)}\right)
\end{aligned}
\tag{32}
$$

The force acting onto device can be expressed as follow

$$
\begin{aligned}
F_r = -\frac{M_e \partial\phi_g}{\partial r} = \\
-\frac{M_e G}{r^2}\left(m - \frac{\pi\varepsilon\varepsilon_0 \alpha_g V_0^2 R \log \frac{(1-\cos\theta_2)(1+\cos\theta_1)}{(1-\cos\theta_1)(1+\cos\theta_2)}}{4\log^2\left(\frac{\tan\theta_2/2}{\tan\theta_1/2}\right)}\right)
\end{aligned}
\tag{33}
$$

Now, the acceleration of device in direction colinear to the earth centre is gravity force divided by device mass

$$
\begin{aligned}
\mathbf{a} = \frac{F_r}{m}\mathbf{e}_r = \mathbf{g}\left(1 - \frac{\pi\varepsilon\varepsilon_0 \alpha_g V_0^2 R \log \frac{(1-\cos\theta_2)(1+\cos\theta_1)}{(1-\cos\theta_1)(1+\cos\theta_2)}}{4m\log^2\left(\frac{\tan\theta_2/2}{\tan\theta_1/2}\right)}\right) = \\
\mathbf{g}\left(1 - \frac{3\varepsilon\varepsilon_0 \alpha_g V_0^2 \log \frac{(1-\cos\theta_2)(1+\cos\theta_1)}{(1-\cos\theta_1)(1+\cos\theta_2)}}{16R^2\rho_c\log^2\left(\frac{\tan\theta_2/2}{\tan\theta_1/2}\right)}\right)
\end{aligned}
\tag{34}
$$

where $\mathbf{g}$ is gravity acceleration near the earth surface.

Most of experiments with electromagnetic propulsion was made on the tangential plane of the earth sphere. Therefore, in it place sun gravity acceleration $\mathbf{g}_{sun} = 0.0058\mathrm{m/s}^2$ projection on the tangential earth surface should be used, which is latitude dependent $0.0058\sin(\phi - 23.44\pi/180)$ and is at least 1690.8 times smaller.

6 Discussion

Obviously, the less difference $\Delta\theta = \theta_2 - \theta_1$ between conic angles the bigger is angular part in eq. (34) (see Fig. 6). On the other hand angular coefficient increases with $\theta_2 - \varepsilon$ where ε is as small as possible but not zero.

Squared voltage 350kV multiplied by permittivity of vacuum gives value 1.084. Let's choose angular coefficient as best as possible (best value in Fig. 6

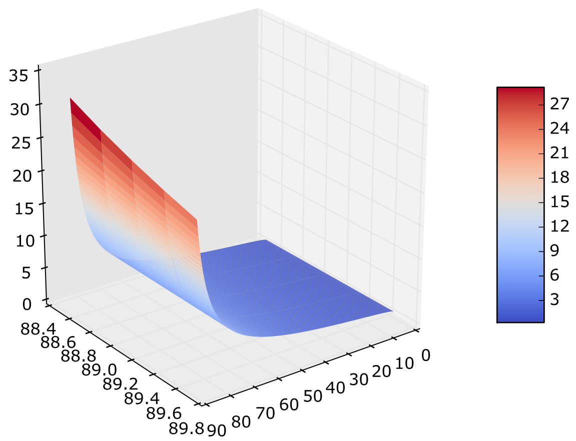

Figure 2: Angular coefficient (eq. (34)) values vs θ_2, θ_1 for $\Delta\theta = 3.5^o$, (the biggest value 32.68)

is 32.68), so we obtain $32\alpha_g \approx 1.5$. Now, let's decide that R of our device is 1 meters. This gives for equation eq. (34) negative acceleration if inequality is satisfied

$$\frac{\varepsilon}{\rho_c} > 3.28 \tag{35}$$

$BaTiO_3$ ceramics with a perovskite structure are capable of dielectric constant values ε as high as 7000 and density is 6000 kg/m^3. A complex perovskite is formed by replacing the Ba portion of $BaTiO_3$ crystal structure with Pb, and the Ti with a mixture of cations such as Mg, Fe, Nb, Zn. Some complex perovskites are ferroelectrics with peak dielectric constants as high as 20,000 and sinter at temperatures below 1000^{o}C (Koripella, 1992). Therefore, today construction of gravity flying device is not physical but also technical problem, although it is still a challenge. We need dielectric material with appropriate ratio of relative permitivity to density and good candidates are barium titanate based complex perovskites, PZT-based piezoelectric ceramics (Uchino, 2010; Hooker, 1998) or other piezoelectric or ferroelectric materials with ultra high relative permitivity and lower enough mass density of this material.

Conclusions

Using equation eq. (22) one can find the acceleration of conical capacitor by obtaining the gradient of gravity potential as follow

$$\mathbf{g} = -\nabla\phi_g = -\frac{\partial\phi_g}{\partial r}\mathbf{e}_r - \frac{1}{r}\frac{\partial\phi_g}{\partial\theta}\mathbf{e}_\theta - \frac{1}{r\sin\theta}\frac{\partial\phi_g}{\partial\phi}\mathbf{e}_\phi \tag{36}$$

which is in general angular dependent for electric charged conical capacitor. Furthermore, acceleration of charged capacitor always negative when non equality is satisfied

$$\rho_c < \frac{\varepsilon\varepsilon_0\alpha_g V_0^2}{2R^2\sin^2\theta_1\log^2\left(\dfrac{\tan\theta_2/2}{\tan\theta_1/2}\right)} \tag{37}$$

Therefore, if this non equality is satisfied, we always will have propulsion in direction opposite to the mass centre of the earth or any other nearest celestial body.

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