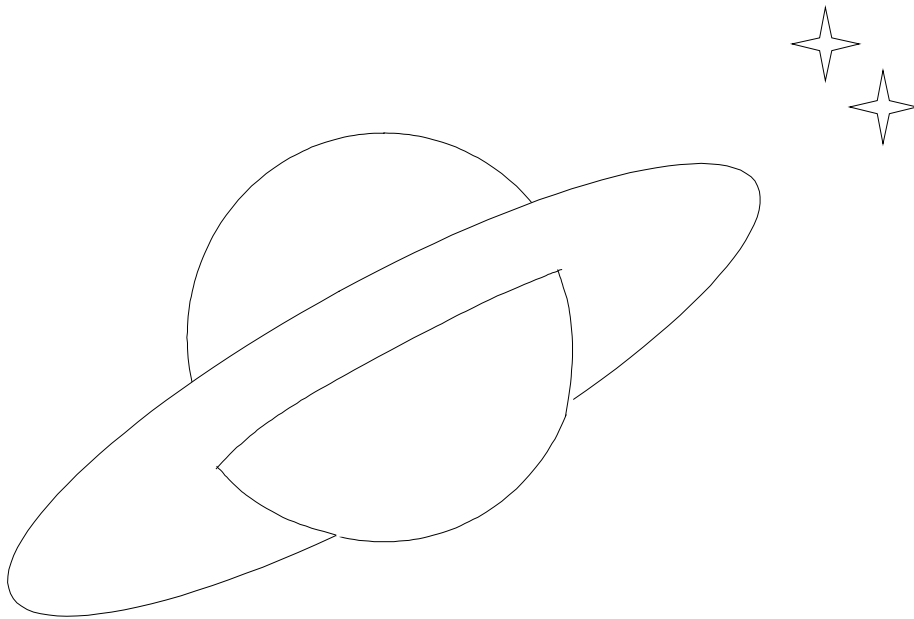


**The Levitron™**  
**A Counter-Gravitation Device for ECE-Theory Demonstration**  
**(Revision 1)**



*Galactican Group*

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**The Levitron™: A Counter-Gravitation Device for ECE-Theory Demonstration****Charles Kellum**

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**ABSTRACT.** The Levitron is a small, inexpensive, anti-gravity device consisting of a base magnet and a top with a magnetic ring attached. The spinning top can be made to "float/levitate" above the magnetic base. Although the levitron-like-device is viewed by some as a toy, it can be used to mimic anti-gravity aspects of ECE-Theory. The ECE-Theory is used to explain the dynamics of a levitron-like-device, including the spin requirement for the top. While the Levitron dynamics have defied quantitative analytical explanation, an attempt was made (circa 1995) by M.V. Berry, then of the Wills Physics Laboratory, UK. Without the benefit of ECE-Theory, Berry attempted to focus on mechanical principles to explain Levitron device operation. The ECE-Theory however, provides a quantitatively accurate description of levitron-like-device dynamics. The Levitron is a counter-gravity, ECE-Theory demonstration device. It can easily be obtained and operated by those new to and/or requiring experimental illustration of ECE-Theory. ECE-Theory is a combination of the geometric approach of Einstein for describing nature, the mathematical methods of Cartan, and the combination of both, formally introduced in 2003, by Dr. Myron W. Evans. Einstein, in his General Relativity Theory of 1915, used the Riemann geometry, in which space is curved. Cartan, in the twenties, showed that Riemann's description of geometry was incomplete. Cartan added torsion (i.e. the concept of spinning spacetime) to the Riemann description. Dr. Evans found the missing piece, that Einstein gravitation is described by curvature, and Cartan Torsion describes the laws of electrodynamics. The same set of equations describe both.

**PACS** numbers: 0420, 0490**1.0 Introduction**

The Levitron [1] is a device consisting of a top (s), with an attached ring magnet ( $M_1$ ), and a magnetic base ( $M_2$ ). It operates on magnetic-levitation (mag-lev)/counter-gravity principles. The spinning top (i.e. the rotating  $M_1$ ) can float stably above  $M_2$ , the magnetic base. A generic configuration is illustrated in Fig. 1 below. Items  $M_1$  (i.e.  $M_L$ ) and  $M_2$  (i.e.  $M_B$ ) are magnetic devices. Figure 2 shows the precession of the top, as its spin degrades. This spin is mechanical, about the magnetization axis of the top. Thus, no rotating magnetic field results. Therefore, we replace the base component of Fig. 2, with a rotating magnetic field.

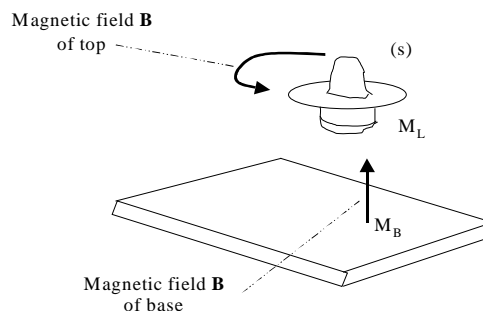


Fig. 1 Generic LEVITRON

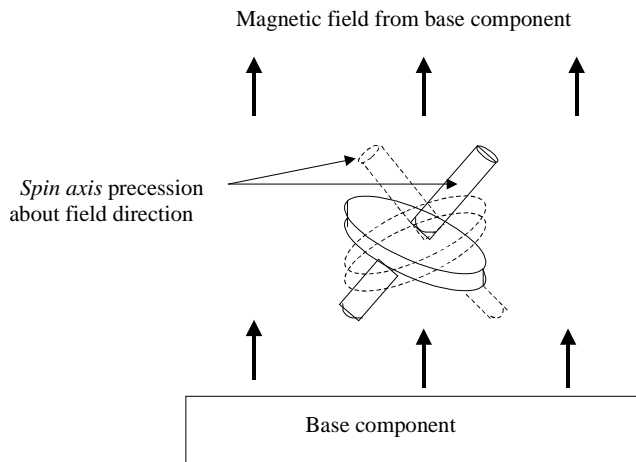


Fig. 2 Precession of Top

The Levitron dynamics has defied a quantitatively accurate explanation until that attempted in [1]. The most definitive paper on Levitron dynamics [1], examines *the mechanics* of the device as a rotating dipole, in a magnetic field. However, for our purpose here, we replace the base component of Fig. 2 with a rotating magnetic field device. Thus, the spinning magnetic top is counter-rotating with the rotating magnetic field. *The remainder of this paper focuses on the dynamics of this “levitron-like-device”*. Thus, the levitron-like-device can be viewed as a demonstration-device for ECE-Theory. The levitron-like-device employs counter-rotating magnetic fields to achieve its counter-gravity effect. It falls in the class of devices defined in [2], [3], and [4].

### 1.1 A Note on Counter-Rotation

We note once again that, for the levitron-like-device,  $M_1$  is attached to the top (s),  $M_2$  is the base. Device operation shows the top must spin to levitate stably above the base. More correctly,  $M_1$  is required to spin.

Let:

$\mathbf{v}_{M_1}$ ,  $\mathbf{v}_{M_2}$   $\rightarrow$  tangential velocities of the magnets  
for counter-rotation ( $\mathbf{v}_{M_1} + \mathbf{v}_{M_2}$ )  $\rightarrow$   $\mathbf{v}_r$  relative velocity.

If  $\mathbf{v}_{M_2} = 0$ , then we have the old Levitron case. For levitation,  $\mathbf{v}_r$  must be positive. Thus, one argues the top must spin. However, it is  $M_1$  that is required to spin, for the levitron-like-device

case. For a levitron-like-device, the rotating magnetic field  $\mathbf{v}_{M2}$  is required because  $\mathbf{v}_{M1} = 0$ , due to the *mechanical* rotation/spinning of the top.

It is useful to note that the explanations of the Faraday disk generator [8], are similar to those of this section. The explanations of the Faraday disk (*homopolar*) generator incorporate ECE-Theory. It has been fully explained by ECE-Theory.

## 2.0 The Spin/Rotation Requirement

For the levitron-like-device, a spin component is needed to couple with spacetime torsion, to achieve spin-connection-resonance (SCR). This spin component must exceed some  $\beta$  to maintain SCR and stability. Stated more precisely, from the above discussion;

$$\begin{aligned} v_r &\geq \beta \rightarrow \text{stability of top above the base} \\ v_r &< \beta \rightarrow \text{instability of top, causing it to fall} \end{aligned}$$

If the levitron-like-device's  $v_{M1}$  spin/rotation component is less than  $\beta$ , the top falls away along a geodesic path induced by the anti-gravity condition caused by the interaction of the levitron-like-device's ring magnet ( $M_1$ ), and magnetic base ( $M_2$ ). This factor is exploited as a propulsion system concept in [3].

### 2.1 Quantitative Analysis Using ECE-Theory

Starting with the ECE Poisson equation:

$$\begin{aligned} \nabla \cdot (\nabla \Phi + \omega \Phi) &= -\rho / \epsilon_0 \\ \nabla^2 \Phi + \omega \cdot \nabla \Phi + (\nabla \cdot \omega) \Phi &= -\rho / \epsilon_0 \end{aligned} \quad 9.6 \text{ of [5]}$$

From section 4.3 of [3], we have the following;

$$(\nabla \mu_1(t) \cdot \mathbf{B}_1(r) + \nabla \mu_2(t) \cdot \mathbf{B}_2(r)) = \Phi_\lambda$$

From [6] we have the following resonance equation;

$$\begin{aligned} d^2\Phi/dr^2 + (1/r - \omega_{int}) d\Phi/dr - (1/r^2 + \omega_{int}/r) \Phi &= -\rho / \epsilon_0 \quad 14.32 \text{ of [6]} \\ \text{Where; } \omega_{int} &\rightarrow \text{the interaction spin connection} \end{aligned}$$

From Coulombs Law  $\nabla \cdot \mathbf{E} = \rho / \epsilon_0$ , one also has  $\mathbf{E} = \nabla \Phi$ . Using  $\Phi_\lambda$  one has the following;

$$\nabla^2 \Phi_\lambda = \rho / \epsilon_0 \text{ (where } \Phi_\lambda \text{ is the driving function)}$$

The driving function  $\Phi_\lambda$  determines the degree of induced curvature  $F(\mu_i, \mathbf{B}_i)$ .

Let;

$$\begin{aligned} (\nabla \mu_1(t) \cdot \mathbf{B}_1(r) + \nabla \mu_2(t) \cdot \mathbf{B}_2(r)) &= \Phi_\lambda \quad (1) \\ \nabla(\mu_1(t) \cdot \mathbf{B}_1(r)) + \nabla(\mu_2(t) \cdot \mathbf{B}_2(r)) &= \\ M_1(r) + M_2(r) &= \end{aligned}$$

---


$$d\Phi_\lambda/dr = dM_1/dr + dM_2/dr \quad (2)$$

$$d^2\Phi_\lambda/dr^2 = d^2M_1/dr^2 + d^2M_2/dr^2 \quad (3)$$

substituting in 14.32 of [6], one has the following;

$$-\rho / \epsilon_0 = (d^2M_1/dr^2 + d^2M_2/dr^2) + (1/r - \omega_{int}) (dM_1/dr + dM_2/dr) - (1/r^2 - \omega_{int}/r) (M_1(r) + M_2(r)) \quad (4)$$

$$-\rho/\epsilon_0 = d^2M_1/dr^2 + d^2M_2/dr^2 + dM_1/dr - \omega_{int} dM_1/dr + dM_2/dr - \omega_{int} dM_2/dr - M_1/r^2 - M_1\omega_{int}/r - M_2/r^2 - \omega_{int}M_2/r \quad (5)$$

From section 4.1 of [3], we use the expression derived for  $\mathbf{H}$ , the geodesic-fall path velocity of a vehicle;

$$M_1M_2/r^2 \approx -K T_{\mu\nu} \\ = \mathbf{H}$$

We then have the following;

$$\left. \begin{aligned} M_1 &\approx -r^2 K T_{\mu\nu} / M_2 \\ dM_1/dr &\approx -r K T_{\mu\nu} / 2M_2 \\ d^2M_1/dr^2 &\approx -K T_{\mu\nu} / 2M_2 \end{aligned} \right\} \text{substituting into eq. (5)}$$

after some algebraic simplification, one has the following;

$$d^2M_2/dr^2 + (1/r - \omega_{int}) dM_2/dr + \omega_{int} K T_{\mu\nu} (r+2) / 2M_2 - (M_2 + r M_2\omega_{int}) / r^2 = -\rho/\epsilon_0 \\ d^2M_2/dr^2 + (1/r - \omega_{int}) dM_2/dr - (1 + r \omega_{int}) M_2/r^2 = -\rho/\epsilon_0 + \text{Constant} \quad (6)$$

Equation (6) is a resonance equation in  $M_2$

An expression for a resonance equation in  $M_1$ , can also be derived in a similar manner. Considering the ECE Poisson equation;

$$\nabla^2\Phi + \boldsymbol{\omega} \cdot \nabla\Phi + (\nabla \cdot \boldsymbol{\omega})\Phi = -\rho/\epsilon_0$$

Arguably, SCR can be achieved relative to  $M_1$ ,  $M_2$ , or  $\Phi$ . The counter-rotation of  $M_1$  and  $M_2$  is needed to amplify  $\Phi$  via SCR. This provides the counter-gravitation effect, and is thus the reason why the magnet ( $M_1$ ), must spin, if counter-gravitation is to be maintained. This is a direct consequence of ECE-Theory.

### 3.0 Quantitative Basics

The primary objective is to show the levitron-like-device as an example of geodesic-fall. Aspects of the ECE-Theory are used to analytically define a spacetime curvature framework for discussions below. The following steps are taken;

- define a coordinate system for the levitron-like-device's top
- define a coordinate system for the levitron-like-device's base
- show gamma-connection between coordinate systems of base and top

Using Bianchi identities (where possible), one can derive gamma-connections between the coordinate systems of the base and the top, where;

$$(x_b, y_b, z_b, t_b) \rightarrow \text{base}; (x_p, y_p, z_p, t_p) \rightarrow \text{top}$$

*Using for example Cartesian coordinates for the base, and spherical coordinates for the top*

From [7], the definitions in this section are used. The general framework of this exercise is taken as two coordinate systems. Generally, an affine connection exists on a smooth manifold, and connects nearby tangent spaces (e.g. coordinate systems) to that manifold. In oversimplification, a Cartan connection is a generalization of an affine connection. The coordinate systems of the top and of the base are considered. An affine connection is;

$$\Gamma_{\lambda\nu}^{\mu} = \{ \lambda^{\mu}{}_{\nu} \} = (\partial x^{\lambda} / \xi^{\alpha}) (\partial^2 \xi^{\alpha} / \partial x^{\mu} \partial x^{\nu})$$

Where;

- $x_{\mu}, x_{\nu}$  are the (*translation and rotation*) coordinates of the base
- $\xi^{\alpha}$  is a free falling coordinate system

$\Gamma_{\mu\nu}^k$  is a gamma connection of differential geometry

$\Gamma_{\mu\nu}^k \neq \Gamma_{\nu\mu}^k \rightarrow$  gamma connection is not symmetric in Cartan geometry  
(*Cartan geometry is a generalization, of the Riemann geometry used in Relativity theory, and the above definition of the affine connection is no longer valid.*)

From the Cartan geometry [9], the antisymmetric connection defines spacetime torsion, which can be represented by the torsion tensor ( $T^{\lambda}{}_{\mu\nu}$ ) where;

$$T^{\lambda}{}_{\mu\nu} = \Gamma^{\lambda}{}_{\mu\nu} - \Gamma^{\lambda}{}_{\nu\mu}$$

$$T^{\lambda}{}_{\mu\nu} = q^{\lambda}{}_a T^a{}_{\mu\nu} \rightarrow \text{torsion tensor (where } q \text{ is a tetrad/frame-field)}$$

At this point we consider some of the primary operational details of the levitron-like-device, in the context of the ECE-Theory. With the discussions of this section, the result should be a quantitatively accurate description of the levitron-like-device's dynamics.

## 3.1 Aspects from Differential Geometry

To begin, we take the conceptual approach of [9], and [10] and set up a basis for the levitron-like-device's top, and a basis for the levitron-like-device's base. We then take the following steps;

- define covariant derivatives for a vector in the top's vector space
  - define covariant derivatives for a vector in the base's vector space
  - take commutator of the covariant derivatives
- (2 torsion tensors should result, considering eq. 9 of [11])

Let:

$$(x_b, y_b, z_b, t_b) = \mathcal{V}^{ob} \rightarrow \text{base}; \quad (x_z, y_z, z_z, t_z) = \mathcal{V}^{oz} \rightarrow \text{top}$$

be base vectors for the coordinate systems of the device's base and top, respectively.

Since a vector is a tensor of rank 1, the covariant derivatives of  $\mathcal{V}^{ob}$  and  $\mathcal{V}^{oz}$  are;

$$D_\mu \mathcal{V}^{ob} = \partial_\mu \mathcal{V}^{ob} + \Gamma_{\mu\theta}^b \mathcal{V}^{o\theta}$$

$$D_\mu \mathcal{V}^{oz} = \partial_\mu \mathcal{V}^{oz} + \Gamma_{\mu\theta}^z \mathcal{V}^{o\theta}$$

As the commutator of covariant derivatives operates on vectors  $\mathcal{V}^{ob}$  and  $\mathcal{V}^{oz}$  we have the following;

$$[D_\mu, D_\nu] \mathcal{V}^{ob} = R^b_{\sigma\mu\nu} \mathcal{V}^{o\sigma} - T^k_{\mu\nu} D_k \mathcal{V}^{ob} \quad \text{and} \quad [D_\mu, D_\nu] \mathcal{V}^{oz} = R^z_{\sigma\mu\nu} \mathcal{V}^{o\sigma} - T^k_{\mu\nu} D_k \mathcal{V}^{oz}$$

Substituting  $D_\mu \mathcal{V}^{ob}$  and  $D_\mu \mathcal{V}^{oz}$  in the expressions for  $[D_\mu, D_\nu] \mathcal{V}^{ob}$  and  $[D_\mu, D_\nu] \mathcal{V}^{oz}$  respectively, yields the following 2 torsion tensors;

$$T_{\mu b}^\theta = q^\theta_a T^a_{\mu b} \rightarrow \text{torsion tensor (from [9]) for the device's base}$$

$$T_{\mu z}^\theta = q^\theta_a T^a_{\mu z} \rightarrow \text{torsion tensor (from [9]) for the device's top}$$

(where: (q) --- is a tetrad/frame-field,  
(a) --- is the index of the tangent space)

Realizing that the device's anti-gravity effect is enabled by induced curvature of spacetime, the interaction of the magnetic fields of its base-component and its top (i.e. the magnetic ring around its top), should be considered. One can replace the connection coefficients  $\Gamma$  with the interactive spin connection  $\omega_{int}$  which (*simplifying indices*) results in the following basis vectors;

$$D_\mu \mathcal{V}^{ob} = \partial_\mu \mathcal{V}^{ob} + \omega_{int} \mathcal{V}^{ob}$$

$$D_\mu \mathcal{V}^{oz} = \partial_\mu \mathcal{V}^{oz} + \omega_{int} \mathcal{V}^{oz}$$

Under ECE-Theory & technology, a primary method for achieving counter-gravity effects is to use the electric field to induce a Newtonian force of sufficient magnitude, and in the opposite direction of gravitational forces. We define:



$\omega_{\text{int}}$  → the interactive spin connection between the device's base & top  
 $\Phi$  → the spacetime electric potential energy

The electric field can be defined as ;

$$\mathbf{E} = -(\nabla + \boldsymbol{\omega}) \Phi$$

The ECE Poisson equation is:

$$\nabla^2 \Phi + \boldsymbol{\omega} \cdot \nabla \Phi + (\nabla \cdot \boldsymbol{\omega}) \Phi = -\rho / \epsilon_0$$

this leads to;

$$d^2 \Phi / dr^2 + (1/r - \omega_{\text{int}}) d\Phi / dr - (1/r^2 + \omega_{\text{int}} / r) \Phi = -\rho / \epsilon_0 \quad 14.32 \text{ of [6]}$$

which is a resonance equation in  $\Phi$ .

In section 2.0, of the main document, an expression for  $\Phi$  is derived.

### 3.2. Generic Counter-Rotation

For the levitron-like-device case,  $M_1$  is attached to the top (s),  $M_2$  is the base. A generalization of this concept is an object (e.g. the device's top) spinning between the  $M_1$  and  $M_2$  magnetic sources. If the object is magnetized (i.e.  $M_3$ ), one has  $M_3$  rotating relative to  $M_1$ , and  $M_3$  rotating relative to  $M_2$  simultaneously. However,  $M_1$  and  $M_2$  are the actual counter-rotating magnetic fields. The  $M_3$  rotation is *mechanical* about its magnetization axis and no rotating magnetic field results. Thus, counter-rotation of  $M_3$  and  $M_1$ , and of  $M_3$  and  $M_2$  is still realized. This results in levitation of the object. Analytically, from section 1.1 above, where;

$\mathbf{v}_{M_1}, \mathbf{v}_{M_2}$  → tangential velocities of the  $M_1$  and  $M_2$  sources' magnetic fields  
 $\mathbf{v}_{M_3}$  → spin velocity of the object's magnetic field

If  $\mathbf{v}_{M_1} = \mathbf{v}_{M_2} > 0$ , and  $\mathbf{v}_{M_3} = 0$ , then  $\mathbf{v}_r$  (from sec. 1.1) is positive, and anti-gravity regions are produced between (counter-rotating)  $M_3$  and  $M_1$ , and between (counter-rotating)  $M_3$  and  $M_2$ , causing the object to levitate.

#### 4.0 Some (levitron-like-device) Operational Details

In this section, examining the force on the top, a gravitation (i.e. mechanical) problem and an electromagnetic problem must be solved. Defining  $\Phi_{\text{top}}$  as the scalar potential energy of the top, it is shown (from [1]) that equilibrium is achieved if  $\nabla \Phi_{\text{top}} = 0$ . If  $\partial^2 \Phi_{\text{top}} / \partial z^2 > 0$ , vertical stability is achieved. Horizontal stability is achieved when  $\partial^2 \Phi_{\text{top}} / \partial x \partial y > 0$ . Considering the field equations of the ECE-Theory, we can write them in a simplified Einstein-like form from [7];

$$\mathbf{G}_{\mu\nu} = -K \mathbf{T}_{\mu\nu} + \ell \mathbf{T}_{\mu\nu}^{\lambda}$$

where; --- the torsion/spin  $\mathbf{T}_{\mu\nu}^{\lambda}$  is accounted for in the ECE-Theory  
 ---  $K$  and  $\ell$  are constants  
 ---  $\mathbf{T}_{\mu\nu}$  is the energy-momentum density

If ;

$$\mathbf{G}_{\mu\nu} = \mathbf{R}_{\mu\nu} - \frac{1}{2} \mathbf{R} \mathbf{g}_{\mu\nu}, \text{ with Ricci tensor } \mathbf{R}_{\mu\nu} \text{ and metric tensor } \mathbf{g}_{\mu\nu} \text{ symmetric}$$

(as defined in the Einstein-Theory)

Then (by ECE-Theory);

$\mathbf{T}_{\mu\nu}^{\lambda}$  is asymmetric, representing spin. We then have equivalencies;

$$\mathbf{F} \approx \mathbf{G}_{\mu\nu} \rightarrow \ell \mathbf{T}_{\mu\nu}^{\lambda} \approx \nabla \boldsymbol{\mu}(t) \cdot \mathbf{B}(r) = \Phi_{\lambda}$$

Where  $\Phi$  is the scalar potential due to counter-rotation of  $M_1$  and  $M_2$ . The rotation of  $M_1$  is a parameter for a driving function ( $\Phi_{\lambda}$ ), to amplify  $\Phi$ . The magnitude of  $M_1$  and its rotation ( $\mathbf{v}_{M1}$ ) determine if SCR is achieved.

Thus, the spin and magnitude of  $M_1$  can be independently adjusted to achieve maximum SCR. Therefor, spin,  $|\mathbf{B}(r)|$ , and curvature are related. QED

The greater the spin and/or the greater the  $\mathbf{B}$  field strength, the greater the induced curvature caused by these conditions. The top's spin acts as a *driving function* to amplify  $\Phi$  (the scalar potential), and thus enhance counter-gravitation between the top & base, at resonance. Going back to equation (1);

$$(\nabla \boldsymbol{\mu}_1(t) \cdot \mathbf{B}_1(r) + \nabla \boldsymbol{\mu}_2(t) \cdot \mathbf{B}_2(r)) = \Phi_{\lambda} \quad (1)$$

Adding rotation vectors gives maximum relative rotation, and implies the rotating magnets are *counter-rotating*. Obviously, if the magnets ( $M_1$  and  $M_2$ ) are rotating in the same direction, the vectors ( $\mathbf{v}_{M1}$ ,  $\mathbf{v}_{M2}$ ) must be subtracted, thus minimizing the rotation effect, *and consequentially any counter-gravitation effect*. In the case of the basic levitron-like-device,  $\boldsymbol{\mu}_1(t) = 0$ . Thus,  $\Phi_{\lambda}$  is derived solely from the rotation ( $\mathbf{v}_{M2}$ ) of  $M_2$  (the rotating magnetic field of the base).

#### 4.1 Vector Potential $\mathbf{A}_{\lambda}$

With the scalar potential  $\Phi_{\lambda}$  defined, the vector potential  $\mathbf{A}_{\lambda}$  is now derived. Using the ECE field equations from [7], one can define a curvature-based analysis of a levitron-like-device. Focusing on *functional equivalencies* of  $\mathbf{F}$  and  $\mathbf{G}_{\mu\nu}$  we have

$$\int \mathbf{F} dq_i = \Delta \Phi_{\text{top}} ; \text{ where } \Phi_{\text{top}} \text{ is the potential energy of the top}$$

From [1], the forces  $\mathbf{F}$  on the device's top (*gravitational and magnetic*) can be defined as follows;

$$\mathbf{F} = -mge_z + \nabla \boldsymbol{\mu}(t) \cdot \mathbf{B}(r) ;$$

where:  $\boldsymbol{\mu}(t)$  is the top's vector moment (*the top considered as a magnetic dipole*)  
 $\boldsymbol{\mu}(t) \times \mathbf{B}(r)$  is the magnetic torque

Equilibrium is achieved if  $\nabla \Phi_{\text{top}} = 0$ . If  $\partial^2 \Phi_{\text{top}} / \partial z^2 > 0$ , vertical stability is achieved. Horizontal stability is achieved when  $\partial^2 \Phi_{\text{top}} / \partial x \partial y > 0$ . As discussed above, using the field equations of the ECE-Theory, we can write from the simplified Einstein-like form;

$$\mathbf{G}_{\mu\nu} = -K T_{\mu\nu} + \ell T^{\lambda}_{\mu\nu}$$

$$\mathbf{F} \approx \mathbf{G}_{\mu\nu} \rightarrow \ell T^{\lambda}_{\mu\nu} \approx \nabla \boldsymbol{\mu}(t) \cdot \mathbf{B}(r)$$

Thus, spin,  $|\mathbf{B}(r)|$ , and curvature are related. **QED**

The greater the spin and/or the greater the  $\mathbf{B}$  field strength, the greater the induced curvature that causes these conditions. The top's spin acts as a *driving function* to amplify  $\Phi$  (the scalar potential), and thus enhance counter-gravitation between the top & base, at resonance. This spin connection resonance (SCR) is defined in [6] thru [8]. As shown above, it too is needed to counter  $\mathbf{G}_{\mu\nu}$ . References [6], [10], and [14] also provide insight as to which kind of resonances can be expected. The induced curvature counters gravitation, in this levitron-like-device case. Changes in spin, due to friction and other mechanical forces, reduce induced curvature. This causes instability in the device, resulting in the device's top falling away from its equilibrium position above the device's base. The observed behavior of the device conforms to this analysis, and the analysis given in [1].

#### 4.1.1 Derivation of $\mathbf{A}_\lambda$ Using ECE-Theory

In the above discussion of section 4, the old Einstein Equation  $\mathbf{G}_{\mu\nu}$  was used. While this is obsolete under the new ECE-Theory, it illustrates that the new ECE-Theory accommodates the Einstein Equation, as a special case of the more general case, under the Cartan Geometry base of the ECE-Theory. This illustration might be useful to those engineers unfamiliar with (or new to) ECE-Theory. Also, as shown below in this section, and section 5.0, use of ECE-Theory greatly simplifies the process for design & analysis of electromagnetic devices. This process simply involves derivation of the vector potential ( $\mathbf{A}$ ) from the force expression ( $\mathbf{F}$ ) of a device. With ( $\mathbf{A}$ ) defined, the angular momentum ( $\mathbf{L}$ ) is derived [16]. Finally, the momentum representations of the "*ECE-Field Equations of Dynamics*" from [15] are used to derive the equations-of-motion. For the levitron-like-device case, the torque on the device's top is used to illustrate this analysis process.

Considering the magnetic torque on the device's top, one can start with the following magnetic force expression;

$$\mathbf{F}_{\text{mag}} = \boldsymbol{\mu}_1(t) \times \mathbf{B}_1(r) + \boldsymbol{\mu}_2(t) \times \mathbf{B}_2(r)$$

and the gravitational (i.e. mechanical) force  $\mathbf{F}_{\text{grv}} = mgz$ , the total force is obviously given as

$$\mathbf{F}_{\text{tot}} = \mathbf{F}_{\text{grv}} + \mathbf{F}_{\text{mag}}$$

This expression can be used to derive the vector potential. From Schrodinger's theory of quantum mechanics, the relation between the potential energy  $\mathbf{A}$  of an object moving under the force  $\mathbf{F}(q_i)$  is defined as;

$$\mathbf{F}(q_i) = \partial \mathbf{A} / \partial q_i$$

Integrating, the expression for the vector potential is;

$$\int \mathbf{F} dq_i = \mathbf{A}$$

Thus  $\mathbf{A}_\lambda$  can obviously be defined as:

$$\int \mathbf{F}_{\text{tot}} dq_i = \mathbf{A}_\lambda$$

With the force, the scalar potential, and the vector potential defined, the *equations of motion* (i.e. momentum, spacetime torsion, torque) can be derived using the ECE force equations from the ECE-Theory Engineering Model [15]. For angular momentum  $\mathbf{L}$ , the following is used;

$$\mathbf{L} = (\nabla \times \mathbf{A}_\lambda - \boldsymbol{\omega} \times \mathbf{A}_\lambda)$$

The torque  $\mathbf{T}$  is defined as;

$$\mathbf{T} = \partial \mathbf{L} / \partial t - \boldsymbol{\mu} \times \mathbf{L}$$

Using the Torsional Force Law of [15];

$$\mathbf{T}_{\mu\nu}^\lambda = \mathbf{F} / E_0 \quad \text{<where } E_0 \text{ is the rest energy>}$$

The field equations are defined as follows, again from [15];

$$\begin{aligned} \mathbf{E} &= -\nabla \phi - \partial \mathbf{A}_\lambda / \partial t + \boldsymbol{\omega}_E \\ \mathbf{B} &= \nabla \times \mathbf{A}_\lambda + \boldsymbol{\omega}_B \end{aligned}$$

The ECE-Theory thus provides a quantitatively accurate description of the dynamics of the levitron-like-device.

#### 4.2 An Application Extension

A propulsion concept can utilize induced spacetime curvature, similar to the levitron-like-device's anti-gravity process. Thus the device's *instability-behavior* (i.e. the top's *fall* away from the base, along the magnetically induced geodesic path) is similar to the fall of a vehicle along such a magnetically induced geodesic path. This fall could constitute vehicular propulsion. However, said vehicle's fall along a geodesic path can be controlled, and *not be a random instability condition*. The parameters governing the instabilities exhibited by the device can be

properly controlled to provide a command & control method for such a propulsion process. Overall, the levitron-like-device (sometimes referred to as a cross-field device) illustrates an application of induced spacetime curvature. ***It should be clear that magnetic forces are not used “directly” to drive the vehicle.***

## 5.0 Application of ECE Antisymmetry Laws

To simplify this analytical process of section 4, the new ECE Antisymmetry laws can be applied. For simplicity, we can concentrate on the electromagnetic portion of the force equation defined in section 4, above.

Given;

$$\mathbf{F}_{\text{mag}} = \boldsymbol{\mu}_1(t) \times \mathbf{B}_1(r) + \boldsymbol{\mu}_2(t) \times \mathbf{B}_2(r) \quad \text{and} \quad \int \mathbf{F} dq_i = \mathbf{A}$$

Let,

$$\boldsymbol{\mu}_1(t) \times \mathbf{B}_1(r) = \boldsymbol{\zeta}_1 \rightarrow \text{the magnetic torque due to } M_1 \text{ rotation}$$

Next, the covariant derivative of  $\boldsymbol{\zeta}_1$  in the field of  $M_2$  is defined. Considering the covariant derivative of  $\boldsymbol{\zeta}_1$  at a point  $p$  (in the field of  $M_2$ ) we have;

$$\begin{aligned} \boldsymbol{\zeta}_1 &= (\mathbf{B}_2^i \zeta_1^j \Gamma_{ij}^k + \mathbf{B}_2^i \partial \zeta_2^k / \partial x^i) \mathbf{e}_k \\ &= \mathbf{B}_2^i (\zeta_1^j \Gamma_{ij}^k + \partial \zeta_2^k / \partial x^i) \mathbf{e}_k \\ &= \mathcal{T}^{\rho p} \end{aligned}$$

Using the notation of equations (1) thru (4) of [12], for consistency & clarity; the commutator of covariant derivatives operates on vector  $\mathcal{T}^{\rho p}$ , as follows;

$$[D_\mu, D_\nu] \mathcal{T}^{\rho p} = R_{\sigma\mu\nu}^{\rho} \mathcal{T}^{\sigma p} - T_{\mu\nu}^{\lambda} D_\lambda \mathcal{T}^{\rho p}$$

Using equation (78) of [12], for  $\mathbf{B}_1(r)$  and  $\mathbf{B}_2(r)$ , we have;

$$\mathbf{B}_1 = (\nabla \times \mathbf{A}_2 - \boldsymbol{\omega} \times \mathbf{A}_2)$$

$$\mathbf{B}_2 = (\nabla \times \mathbf{A}_1 - \boldsymbol{\omega} \times \mathbf{A}_1)$$

where;  $\left\{ \begin{array}{l} \mathbf{A}_2 \text{ is the potential due to } \mathbf{B}_2 \\ \mathbf{A}_1 \text{ is the potential due to } \mathbf{B}_1 \end{array} \right.$

For the scalar potential we use the following;

$$\Phi_\ell = \boldsymbol{\mu}_1(t) \cdot \mathbf{B}_1(r) + \boldsymbol{\mu}_2(t) \cdot \mathbf{B}_2(r)$$

Substituting the driving function  $\Phi_\ell$  into equation (134 of [12], and equation (9.6) of [10]), leads to resonance solutions in  $\Phi$  for the scalar potential. Thus,  $\Phi_\lambda \equiv \Phi_\ell$ , and a cross-field device is functionally & operationally equivalent to counter-rotating magnetic sources. This shows how *The Antisymmetry Laws of the ECE-Theory* can be applied to simplify the analysis process. These laws can be used to design, simulate, and optimize devices whose dynamics are describable by ECE-Theory.

## 6.0 Conclusions

The ECE-Theory is a new unified field theory of physics & cosmology. It answers most questions remaining in cosmology, and has wide application to energy in the areas of electromagnetism and gravitation. One application, *a focus of this document*, is providing a quantitatively accurate description of *levitron-like-device* dynamics. A levitron-like-device is ideal as a mechanism to demonstrate the utility of the ECE-Theory. It is a simple magnetic device. As such, the process of utilizing the ECE-Theory to quantify the dynamics of the levitron-like-device, is straightforward and simple, as shown in this document.

## 7.0 Summary

It has been shown in [2], [3], and [4] that counter-rotating magnetic fields enhance SCR, in accordance with ECE-Theory. Such devices are examples of the *counter-gravitation* and *electrical-energy generation* potential of this technology. The discussion in this paper shows the levitron-like-device could be such a device. More in-depth investigations of levitron-like-device dynamics would focus on counter-rotating magnetic fields, and on an *optimal* theoretical approach. The ECE Coulomb-Law was used in section 2, as an initial theoretical approach for explaining levitron-like-device dynamics.

The levitron-like-device demonstrates the anti-gravity aspects of ECE-Theory in a concise and straightforward manner. The SCR effects, necessary for counter-gravitation are achieved via the rotation of the magnet attached to the levitron-like-device's top, relative to the base magnet of the levitron-like-device. This is the reason why the top (more precisely, the magnet ( $M_1$ ) attached to the top) is required to spin. Mechanical forces, including atmospheric friction, eventually retard the rotation to a value below that required to maintain SCR and stable anti-gravity conditions. The top then falls away, having lost the ability to couple with the torsion of spacetime, in accordance with ECE-Theory. Thus, the levitron-like-device dynamics can be fully explained, *in a quantitatively accurate manner*, by the ECE-Theory.

The levitron-like-device is a small, simple, inexpensive, readily available device that is easy to operate. It can fully demonstrate the anti-gravity aspects of the ECE-Theory. This fact should save much cost and effort that might otherwise be expended, trying to construct demonstrations of the ECE-Theory & technology. Fundamentally, the levitron-like-device should not be viewed as just a mere toy. As discussed above, the levitron-like-device is shown to demonstrate the new ECE-Theory. It is a valuable scientific tool, highlighting ECE-Theory, and pointing the way to a new era in physics & cosmology.

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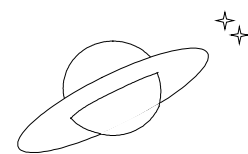
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# **Notes**



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