

# A Theoretical Justification of NASA Electromagnetic Drive based on Cosmic Dark Matter

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Date of publication (dd/mm/yyyy): 22/02/2018

**Abstract** – Based on earlier research results concerning cosmic ordinary energy and dark energy, it is argued that the energy density gradient present in spacetime can produce sufficient thrust to make NASA’s EM drive proposal not only possible but also feasible. This conclusion is also reinforced by a celebrated measure theoretical theorem due to I. Dvoretzky. This should settle the heated controversy of claims and counter claims made by enthusiasts and doubters of the EM drive [1-6]. The main objection about the project is that the theoretical basis contradicts physics connected to Newton’s third law [3]. The present work demonstrates that EM is consistent with the principles of modern quantum cosmology and the Heterotic superstring equations of ordinary and dark energy.

**Keywords** – EM Drive, Interstellar Flight, Vacuum Energy, Cantorian Spacetime, Hartle-Hawking Wave Function, Cantorian Plasma, Quantum Cosmology, Casimir-dark Energy Nano Reactor, Heterotic Superstrings, Ordinary and Dark Energy.

## I. INTRODUCTION

In the present work we advance the thesis that EM drive is in principle possible. To show that nothing could be simpler than appealing to the Heterotic superstring interpretation of dark energy and the Hartle-Hawking universe wave function theory as used in a few recent publications concerned with ordinary cosmic energy density and dark cosmic energy density [7-20]. The first, in the meantime well known, is the energy density of the quantum particle five dimensional zero set which amounts to 4.5% of the total while the rest of 95.5% is related to the quantum wave five dimensional empty set side of the universe [10, 11]. This gradient is sufficient to support a fuelless EM drive enabling interstellar navigation from anywhere to eternity. In fact we need an engine for navigation only, the thrust comes naturally from the local form of one sided Casimir effect of spacetime [11-13]. There is a simple picture associated with the energy density gradient from 4.5% to 95.5% [4, 11, 13]. This picture is based on the quantum E-infinity fact that the quantum wave surrounds and guides the quantum particle which is rather similar to the Bohm-Einstein pilot wave theory [7, 11]. Applying all that to the entire universe we see that a point inside the universe could be thought of as 4.5% quantum particle energy density location while any point at the hyperbolic horizon and the holographic boundary of the universe may be regarded as the 95.5% quantum wave energy density [4, 7, 11]. The same idea is expressed in a different language when we invoke Dvoretzky’s theorem and reason that 95.5% of the volume of the higher

dimensional (i.e. 5D) universe of our real existence lies at a thin layer of the surface [12, 13]. Consequently we expect that any spaceship will be pulled from any point of the interior of the universe towards the hyperbolic boundary of the universe so that a skilful navigation technique could get it from anywhere to anywhere else and practically without expending much fuel except for navigation. This conclusion is reinforced completely by Dvoretzky’s theorem [12, 13]. So much for the theoretical justification of EM drive. We stress once more that our theory goes as far as saying that the thrust is inbuilt into the geometry and topology of the five dimensional vacuum of a fractal spacetime so that the motion of the spacecraft is in principle possible with or without an engine. The engine is initially there mainly to steer up, down, left and right only. Thus solving the main theoretical problem is probably 1% of the difficulties. The rest of the 99% is engineering. We note on passing and in very general terms that dark energy, Hawking vacuum fluctuation, Casimir force and the like differ only with regard to boundary conditions [8]. In other words, the present theory for interstellar flight is a relative of our theory for a Casimir-dark energy nano reactor [14, 15]. For details of the exact calculation of dark matter energy and pure dark energy, the reader may consider Fig. 1 of Ref. 5 as well as the references therein. We also recommend References 4, 34, 25 and 26 for an in depth reading of the mathematical, philosophical and physical background of our theory.

## II. ANALYSIS BASED ON HETEROTIC AND FRACTAL SPACE-TIME

In the following we would like to show quantitatively how a back reaction in empty spacetime can create a thrust, pushing a spaceship forwards without violating conservation of momentum [3]. To do this we will first appeal to the Heterotic string interpretation of the three basic cosmic energy densities, namely the ordinary (4.5%), the pure dark (73.3%) and the dark matter energy density (22.2%) [16-20]. We recall that Einstein’s maximal energy density is given via the Umov-like equation  $E = kmc^2$  when setting  $k = \gamma = 1$  and finding the famous formula  $E = mc^2$  where E is the energy, m is the mass and c is the speed of light [21-22]. We start here by rewriting  $\gamma = 1$  via the Heterotic string formalism as  $\gamma = (22+k)/(22+k)$  where we have subtracted Einstein’s spacetime dimensionality  $D = 4$  from the transfinite bosonic superstrings maximal dimensionality  $26+k$  and found  $26+k-4 = 22+k$  [16-20]. Here k is given by  $\phi^3(1-\phi^3)$  which is ‘tHooft’s

renormalon and amounts to twice the value of Hardy's probability  $\phi^5$  where  $\phi = (\sqrt{5} - 1)/2$  [16-20]. Proceeding in this self explanatory way by writing the three terms expression given in previous publications (see for instance equation (8) of Ref. 17) in a different context [18-20].

$$\gamma = \frac{1 + (5 - \Delta) + (16 + k + \Delta)}{22 + k} \quad (1)$$

we see that our exact ordinary cosmic energy density is given by the first term of equation (1) [16-20]:

$$\begin{aligned} \gamma(O) &= \frac{1}{22 + k} \\ &= 0.04508497187 \\ &\approx 4.5\% \end{aligned} \quad (2)$$

The second term in equation (1) is clearly connected to a Kaluza-Klein quantity, namely a five dimensional object or a topological mass equal 5 so the density is approximately equal  $5/22$ . However we notice an interesting coupling term  $\Delta$  that will play a fundamental role in our theory and the present analysis as will shortly transpire [16, 19, 20]. The third term on the other hand is obviously connected to D. Gross et al extra bosonic dimensions of their Heterotic string theory or more accurately, the transfinite (fractal) version of the classical Heterotic theory which is found by the inclusion of the 'tHooft entangleon  $k$  leading to  $26 + k$  and  $22 + k$  instead of the classical 26 and 22 [19, 20]. We see again the same  $\Delta$  appearing but with a positive sign. Clearly  $-\Delta + \Delta = 0$  and we will dwell on the annihilation of  $\Delta$  involved which is reminiscent of but by no means identical to Hawking's radiation at the edge of a black hole when interpreting  $\Delta$  as an exotic virtual particle [23]. Again we recall that  $\Delta$  was found to be given by  $\Delta = (8 + k^2)/100$  and that the exact values of pure dark energy density and dark matter energy density follow from fixing this coupling term or couplion particle at this value [19, 20]. On the other hand  $\Delta$  has another remarkable interpretation when  $\gamma(DM)$  is rewritten in the form of first the difference between matter like densities, namely the dark matter energy density  $\gamma(DM) = (22 + k)/100 = 0.2218033989$  and the ordinary energy density  $\gamma(O) = 1/(22 + k)$  as on the first line of equation (3) and second as the difference between 5 and  $(22 + k)$  multiplied with the first difference as shown on the third and fourth line of the same equation (3) [16-20]. Continuing in this admittedly not very obvious way to start with, one finds the exact energy density of dark matter and the meaning becomes more clear a posteriori, namely.

$$\begin{aligned} \gamma(DM) &= \frac{[0.2218033989 - (1/22 + k)](22 + k)}{22 + k} \\ &= \frac{(0.17618427)(22 + k)}{22 + k} \\ &= \frac{3.919674776}{22 + k} \\ &= \frac{5 - 0.08032522476}{22 + k} \\ &= \frac{5 - \Delta}{22 + k} \end{aligned} \quad (3)$$

exactly as it should be [19, 20]. Now the same thing can be done for the pure dark energy density side involving the Gross  $16 + k$  bosons, namely [16-20].

$$\gamma(PD) = \frac{16 + k + \Delta}{22 + k} \quad (4)$$

Applying the above to the balance of forces acting on our "fuel-less" spaceship, we see that  $\pm \Delta$ , interpreted as quasi quantum particles, can solve the problems of creating a vacuum thrust pushing the spaceship "forward" without violating fundamental conservation laws of physics [1-3]. Thus  $+\Delta$  would be sucked by the hyperbolic horizon of pure dark energy at infinity while the  $-\Delta$  gives the spaceship the needed jolt to go forward.

The preceding interpretation could be formulated using a lower dimensionality theory, namely that of a fractal Kaluza-Klein  $D = 5 + \phi^3$  [18-26]. In this case we would have the same exact densities

$$\begin{aligned} \gamma(O) &= \frac{\phi^3}{5 + \phi^3} \\ \gamma(DM) &= \frac{1 + \Delta}{5 + \phi^3} \end{aligned} \quad (5)$$

and

$$\gamma(PD) = \frac{4 - \Delta}{5 + \phi^3} \quad (6)$$

However the coupling  $\Delta$  changes to  $\Delta = k - [(8 + k^2)/100]/(4 + \phi^3)$  and the plus and minus are exchanged. This exchange of signs is harmless because in an infinite spacetime manifold plus and minus as well as up and down or left and right are all conventions and nothing more than that. At the end all what matters is that  $+\Delta - \Delta = 0$  and we have the vacuum thrust, which does not violate conservation of momentum [3]. However we see that not even Newton's third law could be blindly applied when it comes to the empty set vacuum [14-20] and the two types of dark energy, i.e. dark matter energy and pure dark energy [22].

### III. CONCLUSION

The quantum topology of our universe dictates that it is made up of two parts, (a) a low density interior with 4.5% energy density and (b) a high energy density surface with 95.5% of the total energy. This gradient is what makes fuelless interstellar journeys possible so that we can state without any doubt that in principle EM drive is science and not science fiction any more. On the other hand any ordinary EM engine can be used because it is needed for navigation only. However to enhance the local cosmic thrust it may be possible to design an EM drive which does exactly that along the lines explained in the analysis of Section 2 of the present work, but this is another major engineering problem which is not the main concern in the present paper.

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### AUTHOR'S PROFILE



Professor **M.S. El Naschie** was born in Cairo, Egypt on 10th October 1943. He received his elementary education in Egypt. He then moved to Germany where he received his college education and then his undergraduate education at the Technical University of Hannover where he earned his (Dipl-Ing) diploma, equivalent to a Master's degree in Chartered Structural Engineering. After that he moved to the UK where he enlisted as a post graduate student in the stability research group of the late Lord Henry Chilver and obtained his Ph.D. degree in structural mechanics under the supervision of Professor J.M.T. Thompson, FRS. After his promotions up to the rank of full professor, he held various positions in the UK, Saudi Arabia and USA and was a visiting professor, senior scholar or adjunct professor in Surrey University, UK, Cornell, USA, Cambridge University, UK and Cairo University, Egypt. In 2012 he ran for the Presidency of Egypt but withdrew at the final stage and returned to academia and his beloved scientific research. He is presently a Distinguished Professor at the Dept. of Physics, Faculty of Science of the University of Alexandria, Egypt.

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Professor El Naschie is the single or joint author of about one thousand publications in engineering, physics, mathematics, cosmology and political science. His current h-index is 74, his i-10 index is 755 and his citations according to Google Scholar is 31439.