Advanced Propulsion Workshop -2017

Entanglement Drive

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Part 1

Generalized Form of a
New Non-Gravitational Acceleration Equation

Acceleration of the Density Field
(Like a Warp Bubble)

Estimated Radius of the Accelerated Density Field

Unit Vector

$$\boldsymbol{a}_c \equiv \boldsymbol{a}_{\phi_c} = 6\left(\varphi^3\sqrt{\frac{R_{\phi_a}}{l_p}}\right)^{1/2} g_M \,\hat{\boldsymbol{\phi}}$$

Object's Acceleration

Phase Factor

Local Acceleration of Gravitation

Planck Length

$c \equiv$ object under study

$\phi \equiv$ Density Field

$\phi_a \equiv$ Accelerated Density Field

$M \equiv$ Local Gravitation Source

Like a time change ratio between the Warp Bubble and the reaction mass in the Warp Bubble
with respect to its effect on the Universe

Chameleon Cosmology

Thin-Shell **(i.e., Warp Bubble)**

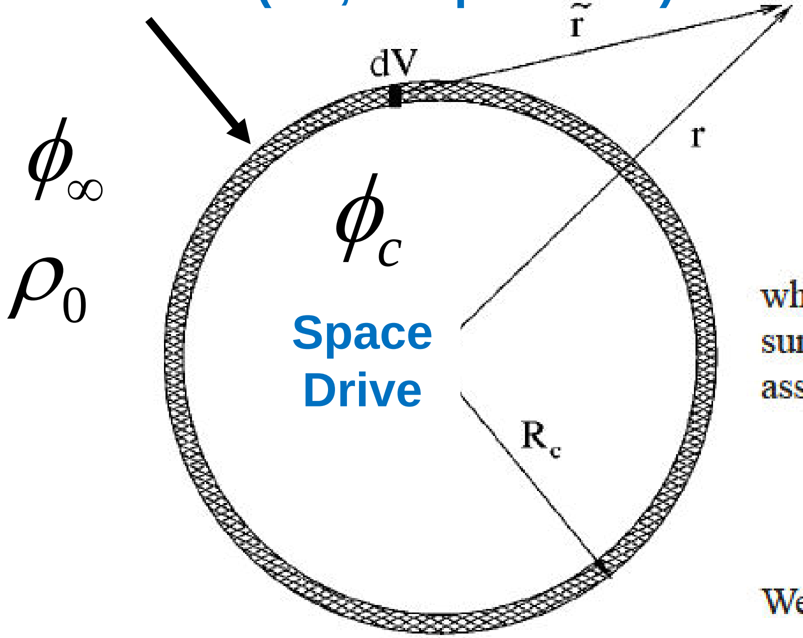


FIG. 4. For large objects, the ϕ field a distance $r > R_c$ from the center is to a good approximation entirely determined by the contribution from infinitesimal volume elements dV (dark rectangle) lying within a thin shell of thickness ΔR_c (shaded region). This thin-shell effect suppresses the resulting chameleon force.

External Field   Internal Field

$$\frac{\Delta R_c}{R_c} = \frac{\phi_\infty - \phi_c}{6\beta M_{Pl}\Phi_c}, \tag{16}$$

where $\Phi_c = M_c/8\pi M_{Pl}^2 R_c$ is the Newtonian potential at the surface of the object. The derivation of Eq. (15) implicitly assumed that the shell was thin, that is,

$$\frac{\Delta R_c}{R_c} \ll 1. \tag{17}$$

We shall henceforth refer to this as the thin-shell condition.

All things have a thin-shell of thickness

$$\Delta R_c$$

Chameleon Cosmology:
Generalized Thin-Shell Thickness

Energy Scale Factor

$$\Delta R_c \approx \frac{1}{3}\left(\frac{M^2}{\rho_c R_c}\right)\left(\frac{2M_{PL}^4}{\rho_0}\right)^{1/3} = \frac{\kappa_0}{\rho_c R_c}$$

The Mass's Density
(Space Drive Density)

The Local Environmental Density (*i.e., Atmosphere*)

The Mass's Radius
(Space Drive Radius)

$$M_{PL} = \frac{m_p}{\sqrt{8\pi}}$$

Reduced Planck Mass

$$\kappa_0 = \frac{1}{3}M^2\left(\frac{2M_{PL}^4}{\rho_0}\right)^{1/3}$$

Modified Chameleon Model

It then follows that $\phi \sim \phi_{atm}$ in the atmosphere.

For an inverse power-law potential, $V(\phi) = M^{4+n}\phi^{-n}$, Eq. (10) can be translated into a constraint on the scale M which, for n and β of order unity, is given by [4]:

$$M \lesssim 10^{-3}\ \mathrm{eV} \approx (1\ \mathrm{mm})^{-1}\,. \qquad (11)$$

Remarkably, this coincides with the energy scale associated with the dark energy causing cosmic acceleration [5].

In my analysis, it was found that $n = 2$ and β not necessarily the order unity

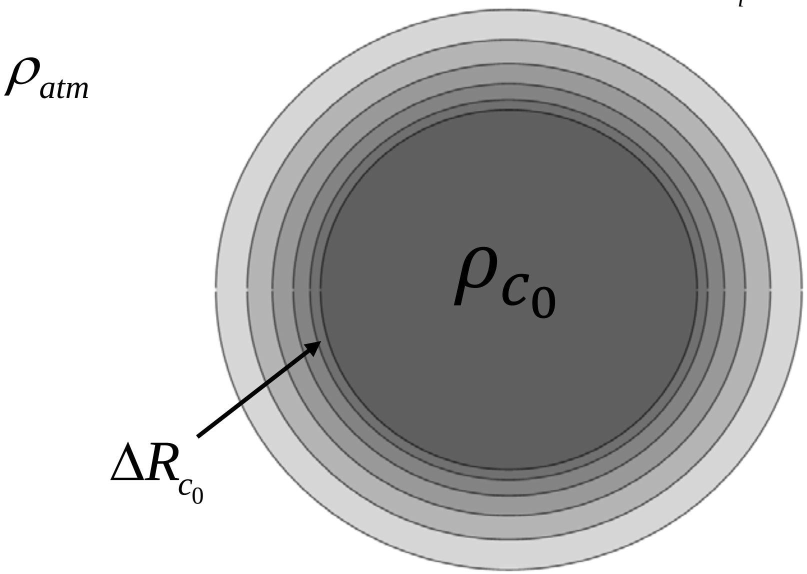
$$M \equiv M_E \approx \left(\frac{\Lambda}{8\pi l_p^2}\right)^{1/4} \approx 11378\ m^{-1} \approx (0.1\ mm)^{-1}$$

which is a Cosmological **Energy Scale Factor**.

Λ **- Cosmological Constant**

ENTANGLEMENT AND CHAMELEON COSMOLOGY

$$\Delta R_{c_i} \approx \frac{\kappa_0}{\rho_{c_i}\left(R_{c_0} + i x_{\min}\right)}; \; i = 0,\ 1,\ 2,\ 3,\ \ldots$$



"Space-time Entanglement is not a physical connection, but a shared history," Science News 7 Oct, 2015.

That is, the empty space in the Universe is a time-wise compilation of the thin-shell energies generated from the mass in the Universe over time.

By applying Susskind's interpretation of entanglement to the thin-shell mechanism in Chameleon Cosmology, one can allow the thin-shell(s) to be the observer between an object's density and its surrounding environment density. Whereby, changes to these densities invoke changes to the thin-shell thickness in order to conserve both entanglement and energy between the two densities.

Susskind, Leonard, "Copenhagen vs Everett, Teleportation, and ER=EPR," arXiv:1604.02589 v2 [hep-th], 23 Apr. 2016.

-- The fabric of Space-time is composed of thin-shells --

Chameleon Cosmology: Gravity Force Equation

$$\boldsymbol{F}_g = m_c \boldsymbol{g}_M$$

Chameleon Acceleration → $\boldsymbol{a}_c = -6\beta_c \left(\frac{\Delta R_c}{R_c} \right) \boldsymbol{g}_M$

Gravity Force

$$\boldsymbol{F}_g + \boldsymbol{F}_c = \left[1 - 6\beta_c \left(\frac{\Delta R_c}{R_c} \right) \right] \boldsymbol{F}_g$$

Chameleon Force

Given that:

1. *The fabric of Space-time is composed of thin-shells*
2. *The Chameleon acceleration is a subtraction from gravity*

Then under Warp Drive Terminology:

- *The energy in the thin-shell is* *exotic energy* *that carries a negative acceleration vector with respect to gravity.*

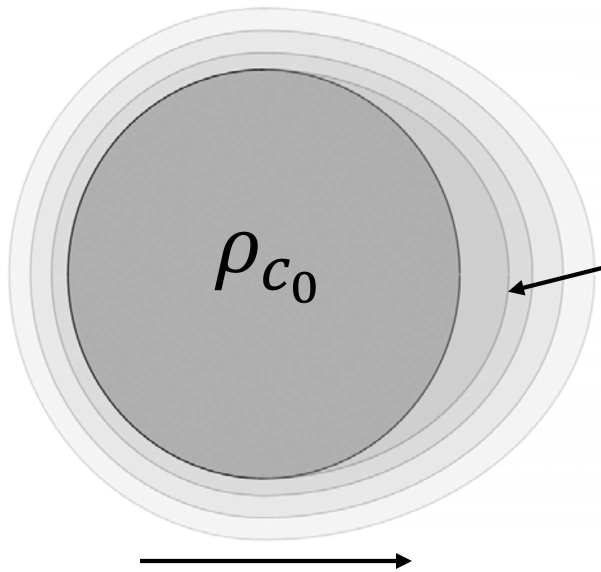
NEW ACCELERATION MECHANISM

Accelerated Thin-Shell Model

$$\left(\Delta R_{c_i}\right)_{\phi_a} \equiv \Delta R_{\phi_{a_i}} \approx \frac{\kappa_0}{\rho_{\phi_{a_i}} R_{\phi_{a_i}}}$$

Estimated Radius of the Accelerated Density Field

Accelerated Density Field



ρ_{atm}

$\Delta R_{\phi_{a_o}} \equiv \Delta R_{\phi_a}$

Accelerated Thin-Shell

Motion

The density field of an object is defined by the density within the outer perimeter of its thin-shell.

Whereby, the acceleration of an object is due to the change in an object's density field or thin-shell thickness, in the direction of motion, in order to conserve momentum between the object and the thin-shell, while still conserving the entanglement and energy between the object's density and its environment's density.

Accelerated Density Field and Radius

For non-random internal reaction-mass accelerations

Case 1: Ballistic Object (Type I)

Object with reaction mass $m_k = m_c$ having acceleration $a_k = a_c$ with no Mass ejected

$$\rho_{\phi_a} = \rho_c + \left(\frac{a_c}{g_M}\right)\rho_c = \frac{3}{4\pi}\frac{m_c}{R_{\phi_a}^3} \Rightarrow R_{\phi_a}^3 = \left(1 + \frac{a_c}{g_M}\right)^{-1} R_c^3$$

Case 2: Entanglement Drive (Type I)

Object with reaction mass $m_k < m_c$ having acceleration $a_k > a_c$ with no Mass ejected

$$\rho_{\phi_a} = \rho_c + \left(\frac{a_k}{g_M}\right)\rho_k = \frac{3}{4\pi}\frac{m_c}{R_{\phi_a}^3} \Rightarrow R_{\phi_a}^3 = \left(1 + \left(\frac{a_k}{g_M}\right)\left(\frac{m_k}{m_c}\right)\right)^{-1} R_c^3$$

Case 3: Rocket Type Object (Type II)

Nozzle with reaction mass $m_k = m_{ex}$ having acceleration $a_{ex} > a_c$ being ejected

$$\rho_{\phi_{nozzle}} = -\left(\frac{a_{ex}}{g_M}\right)\rho_{ex} \approx -\frac{3}{4\pi}\frac{m_{ex}}{R_{\phi_{nozzle}}^3} \qquad R_{\phi_{nozzle}} \approx \sqrt{2}R_{nozzle\ exit}$$

ACCELERATION MECHANISM
Accelerated Thin-Shell Model

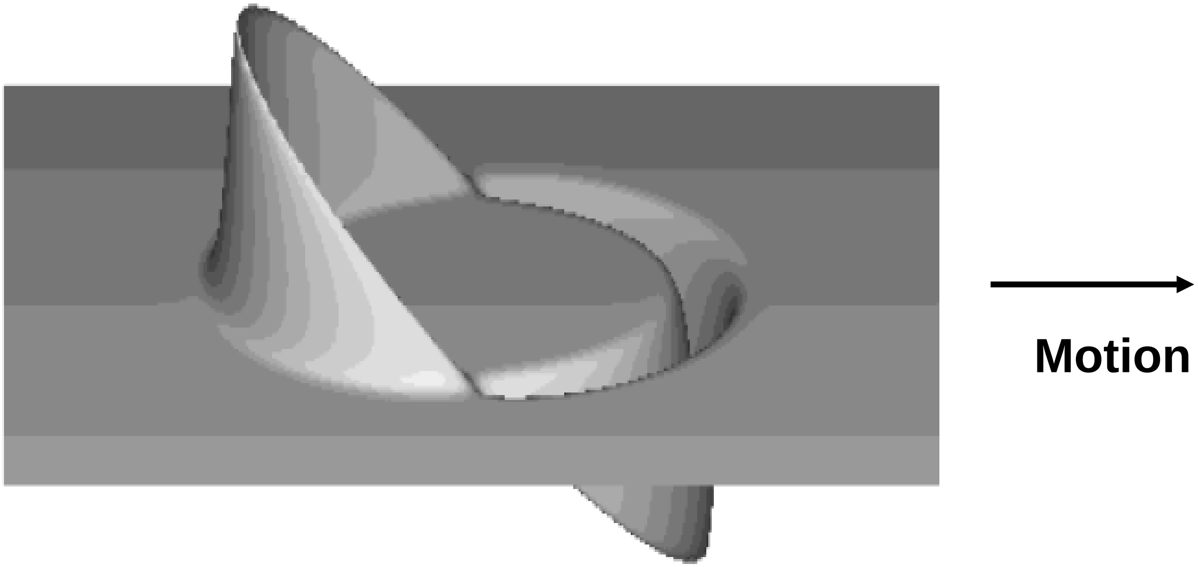
Given that:

1. *The fabric of Space-time is composed of thin-shells*
2. *The energy in the thin-shell is exotic energy*

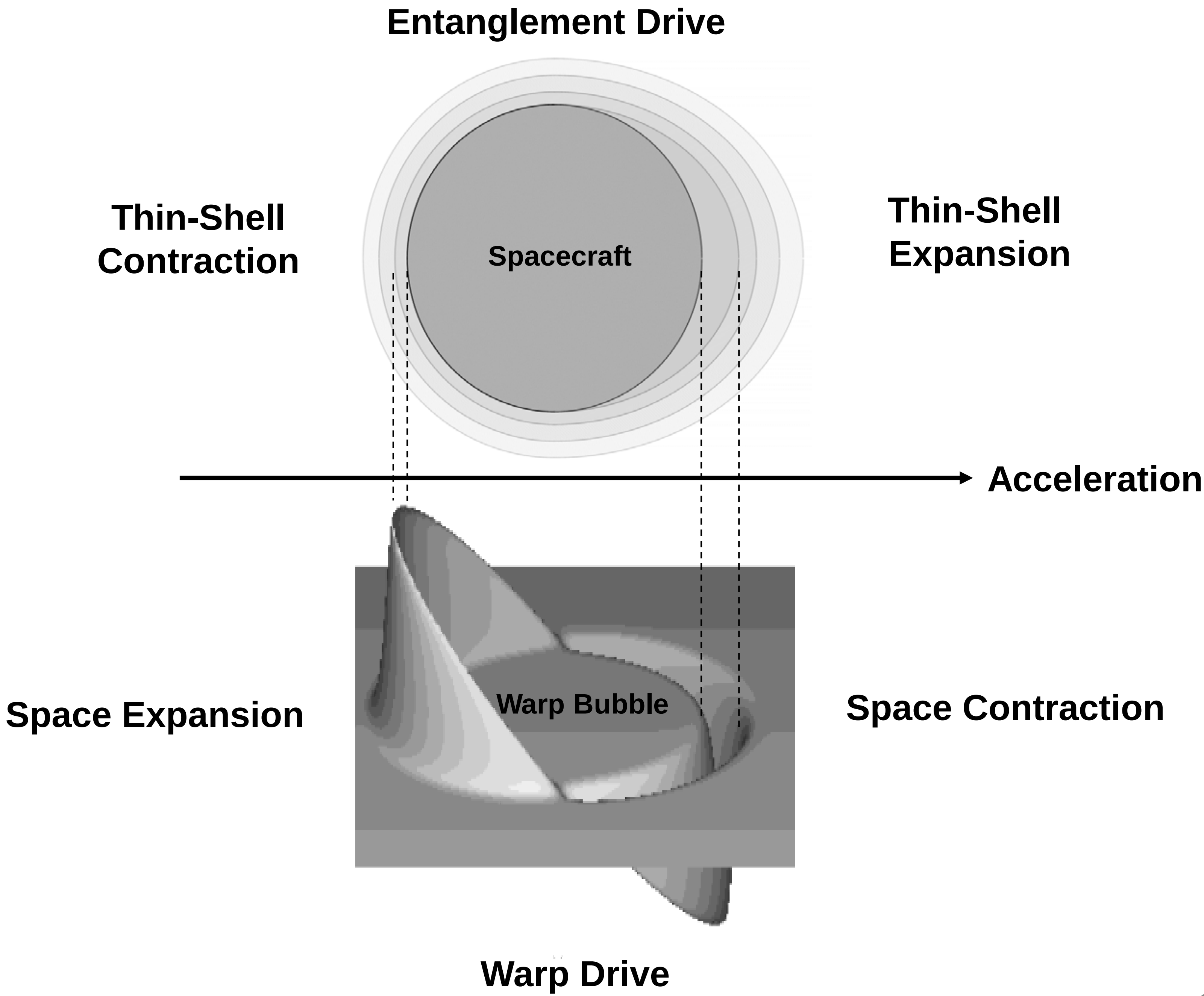
Then:

An <u>accelerated density field</u> is a

“Warp Bubble.”



Motion


Entanglement Drive
Thin-Shell Contraction
Spacecraft
Thin-Shell Expansion
Acceleration
Space Expansion
Warp Bubble
Space Contraction
Warp Drive

ACCELERATION MECHANISM

Accelerated Thin-Shell Model

Gravitational Coupling Factor

$$\Delta R_c \approx \beta_G^2 \sqrt{l_p R_c}$$

Chameleon Cosmology Thin-Shell

$$\Delta R_{\phi_a} \approx \beta_G^2 \sqrt{l_p R_{\phi_a}}$$

Accelerated Thin-Shell

Estimate of the Accelerated Density Field Radius

ACCELERATION MECHANISM
Accelerated Thin-Shell Model

Phase Factor

$$\Delta R_{\phi_a} \approx \beta_G^2 \sqrt{l_p R_{\phi_a}} \approx \varphi \left(\frac{\beta_G^2}{\beta_{\phi_a}^2} \right)^{1/3} R_{\phi_a}$$

Estimate of the Accelerated Density Field Radius

Acceleration Coupling Factor

Phase Factor

$$\varphi \equiv \frac{\textit{time rate of change of the } \text{Warp Bubble}}{\textit{time rate of change of the accelerated } m_k} \qquad \alpha_U \approx \left(\frac{dt_\phi}{dt_k}\right)\alpha_U$$

$$\alpha_U \equiv \frac{\textit{Universe normalization of } dt_k}{\textit{Universe normalization of } dt_\phi} = \frac{dt_{k_U}}{dt_{\phi_U}}$$

$$dt_\phi \approx dt_{\phi_U}$$

Implies a Mach Effect System

Phase Factor

$$M_E \approx \left(\frac{\Lambda}{8\pi l_p^2}\right)^{1/4}$$

Case 1: Ballistic Object

$$dt_{\phi_U} = dt_\phi ;\quad dt_{k_U} = \left(\frac{1}{\eta_k M_E R_c}\right) dt_k ;\ \ \varphi \approx \frac{1}{\eta_k M_E R_c}$$

Case 2: Entanglement Drive (Type I)

$$dt_{\phi_U} = \left(\eta_\phi M_E d_k\right) dt_\phi ;\quad dt_{k_U} = \left(\frac{1}{\eta_k M_E R_c}\right) dt_k ;\ \ \varphi \approx \left(\frac{1}{\eta_\phi M_E d_k}\right)\left(\frac{1}{\eta_k M_E R_c}\right)$$

Case 3: Rocket Type Object (Type II)

$$dt_{\phi_U} = dt_{k_U} ;\ \ \varphi \approx \frac{dt_\phi}{dt_k} ;\quad \varphi \approx \frac{R_{\phi_{nozzle}}}{v_{ex}} \frac{\dot{m}}{m_{ex}}$$

$$R_{\phi_{nozzle}} \approx \sqrt{2} R_{nozzle\ exit}$$

Geometric Factors

Geometric factors result from the Universe scale normalization

η_k - accelerated mass geometric factor

η_ϕ - field density geometric factor

Where generally, so far:

Case 1: $\eta_k \approx X\pi$

Case 2: $\eta_k \eta_\phi \approx Y\pi$

Generalized
Non-Gravitational Acceleration

$$\boldsymbol{a}_{\boldsymbol{\phi}_c} = 6\beta_{\phi_a}\left(\frac{\Delta R_{\phi_a}}{R_{\phi_a}}\right) g_M \ \hat{\boldsymbol{\phi}} \approx 6\left(\varphi^3\sqrt{\frac{R_{\phi_a}}{l_p}}\right)^{1/2} g_M \ \hat{\boldsymbol{\phi}}$$

Accelerated Density Field Form of Chameleon Acceleration

$$\boldsymbol{a}_c = 6\beta_c\left(\frac{\Delta R_c}{R_c}\right) g_g \hat{\boldsymbol{\phi}}$$

Generalized
Non-Gravitational Acceleration

Case 1: Ballistic Object

$$\boldsymbol{a}_{\phi_c} \approx 6\left(\varphi^3\sqrt{\frac{R_{\phi_a}}{l_p}}\right)^{1/2} g_M\ \hat{\boldsymbol{\phi}} \approx \boxed{\frac{\boldsymbol{F}_{applied}}{m_c} = \boldsymbol{a}_c}$$

$$\varphi \approx \frac{1}{\eta_k M_E R_c} \qquad \eta_k \approx 8\pi$$

$$R_{\phi_a} = \frac{R_c}{\left(1+\frac{a_c}{g_M}\right)^{1/3}}$$

Generalized
Non-Gravitational Acceleration

Case 3: Internal mass acceleration with ejected Mass (i.e., Rocket)

$$\boldsymbol{a}_{\phi_r} \approx 6\left(\varphi_r^3 \middle/ \left[\sqrt{l_p}\left(\frac{1}{\sqrt{R_{\phi_T}}} - \frac{1}{\sqrt{R_{\phi_{nozzle}}}}\right)\right]\right)^{1/2} g_M \;\hat{\boldsymbol{\phi}} \approx \boxed{\frac{\boldsymbol{T}_{BO}}{m_{BO}} = \boldsymbol{a}_{rocket}}$$

$$\varphi_r \approx \eta\left(\frac{R_{\phi_{nozzle}}}{v_{ex}}\right)\left(\frac{\dot{m}_{ex}}{m_{ex}}\right)$$

$$R_{\phi_T} \approx \text{ Throat Radius}$$

$$R_{\phi_{nozzle}} \approx \sqrt{2} \times \text{Exit Radius}$$