Supplementary Chapter

Solving the Flyby Anomaly by the General Relativity of CFLE Theory

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1. The Flyby Anomaly

The flyby or swing-by is a method used in interplanetary space flight to alter the path and the speed of a space craft, using the gravity of a planet. This technique has many advantages, including higher velocities for reaching distant planets, resulting in related time, fuel, and cost savings, and easy access to orbits far from the ecliptic, as well as being repeatable.

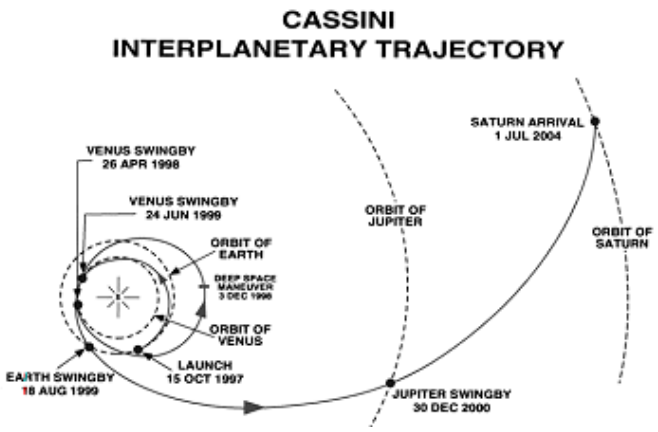

Figure 1-1. Cassini interplanetary swing-bys
(Source: Courtesy NASA/JPL-Caltech)

The flyby anomaly, which was first observed in the early 1990s, is an unexpected increase or decrease in energy experienced by a space craft executing Earth flybys.

The anomaly was observed as shifts in the S-band and X-band Doppler and ranging telemetry by an international network of communication facilities for the support of interplanetary space craft missions and radar astronomy, called the Deep Space Network (DSN). This network has three facilities: the Goldstone DSN complex, Mohave Desert, California, USA; the Madrid DSN complex, Robledo, Spain; and the Canberra DSN complex, Tidbinbilla, Australia (Figure 1-2).

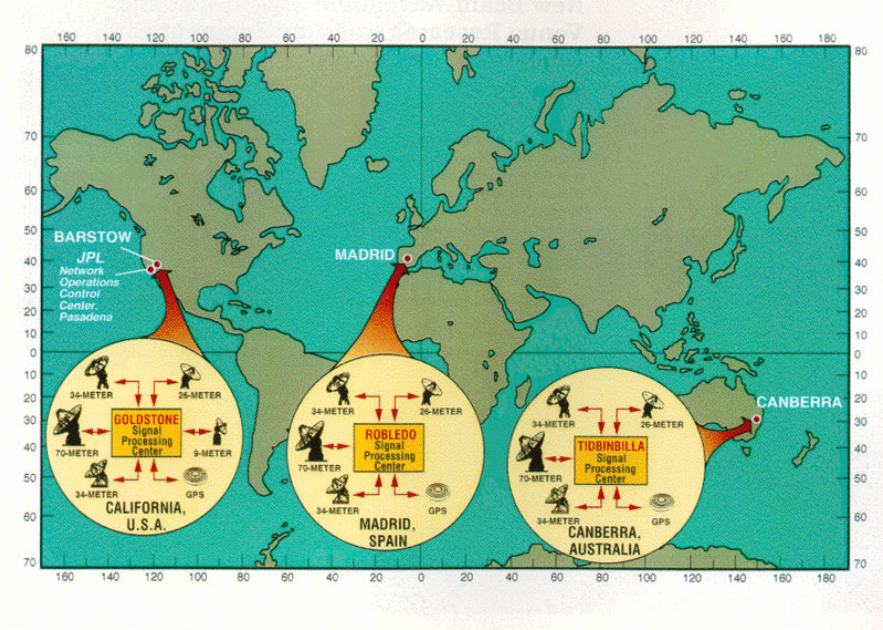

Figure 1-2. Locations of the Deep Space Network (DSN)
(Source: Courtesy NASA/JPL-Caltech)

The main method for measuring the velocity of a space craft is by observation of these two electromagnetic wave bands, where the designed accuracy of the DSN measurement is ~0.01 mm/s. The anomaly was picked up by J. D. Anderson and other engineers at the Jet Propulsion Laboratory (JPL) during an inspection of DSN Doppler data, shortly after the Earth flyby of Galileo 1 on 8th December 1992. The Doppler residual usually remains flat, but the analysis revealed an unexpected 66 mHz shift, which corresponds to a velocity increase of 3.92 mm/s at perigee.

An investigation of this anomalous increase at the JPL, the Goddard Space Flight Center (GSFC), and the University of Texas did not yield any satisfactory explanations. Then on 23rd January 1998, the Near Earth Asteroid Rendezvous (NEAR) space craft gained an anomalous velocity increase of 13.46 mm/s after its Earth encounter. This incident was followed by the Cassini space craft experiencing −1.7 mm/s at perigee on 18th August 1999.

Table 1-1 summarizes some important parameters related to these three anomalous flyby incidents.

Table 1-1. Some important parameters related to anomalous space craft flyby incidents.

	Galileo I	NEAR	Cassini
Date	12/8/1992	01/23/1998	08/18/1999
Speed at infinity	8.949 km/s	6.851 km/s	16.01 km/s
Speed at perigee	13.738 km/s	12.739 km/s	19.03 km/s
Trajectory inclination to equator	142.9°	108.8°	25.4°
Minimal altitude	956 km	532 km	1172 km
Speed increment at infinity	3.92 ± 0.08 mm/s	13.46 ± 0.13 mm/s	–2 ± 1 mm/s
Speed increment at perigee	2.56 ± 0.05 mm/s	7.21 ± 0.07 mm/s	–1.7 ± 0.9 mm/s

(Source: Wikipedia at http://en.wikipedia.org/wiki/Flyby_anomaly; accessed December 10, 2012)

1.1. Proposed equation

An empirical equation for the anomalous flyby velocity change was proposed by J. D. Anderson and his collaborator J. Jordan. That is,

$$\frac{dV}{V} = \frac{1}{2}\frac{\Delta E}{E} = K(\cos\varphi_i - \cos\varphi_0), \quad K = \frac{2\omega_e R_e}{C} = 3.1 \times 10^{-6} \qquad \text{1-1-1}$$

where ω_e is the angular frequency of the Earth, R_e is the Earth radius, and φ_i and φ_0 are the inbound and out-bound equatorial angles of the space craft, respectively.

Based on this equation, Anderson and his colleagues predicted a speed increase of 1 mm/s for the Rosetta space craft flyby on 13th November 2007. The data analysis, however, revealed that Rosetta's flyby was complete, and absent of flyby anomalies.

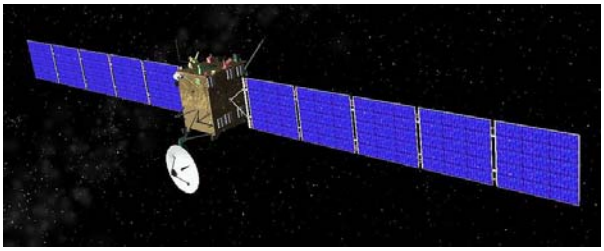

Figure 1-1-1. Computer model of Rosetta
(Source: Wikipedia; http://en.wikipedia.org/wiki/File:Rosetta.jpg)

1.2. Results

Many possible explanations about the flyby anomalies have been proposed, with fancy titles such as the Transversal Doppler Effect; Dark Matter Halo Around the Earth; The Casimir Effect; The Impact of General Relativity; and General Relativity Combined with a Rotating Universe. However, none of these explanations can be universally accepted. Therefore, this important problem remains listed as a mystery as to what causes the unexpected change in acceleration or deceleration for space craft planetary flybys.

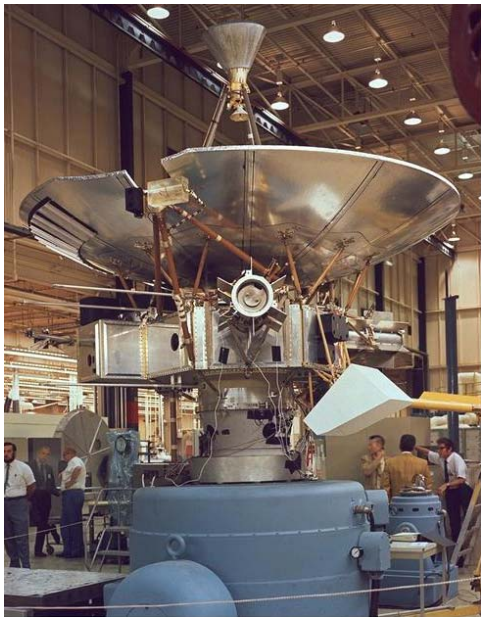

Figure 1-2-1. Pioneer 10 final construction phase
Launched March 2, 1972. Anomaly observed,
$\boldsymbol{\alpha_{\text{Pioneer}} = -(8.74 \pm 1.33) \cdot 10^{-10}}$ **m/s^2**
(Source: Courtesy NASA Ames Research Center)

2. Solving the Flyby Anomaly by the General Relativity of CFLE Theory

2.1. Galileo 1

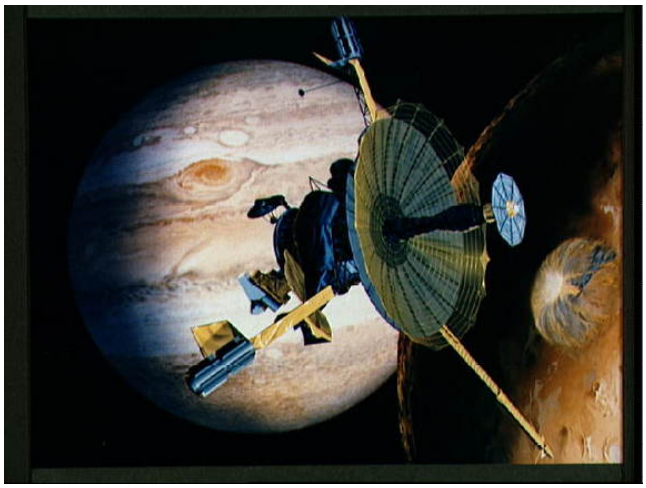

Figure 2-1-1. Artist's conception of Galileo 1 near Jupiter
(Source: Courtesy NASA)

According to special relativity, the additional classical electric force appears as a magnetic force. That is

$$F = Q\,(E + V \times B) \qquad 2\text{-}1\text{-}1$$

$$B = \frac{V}{C^2} \times E \qquad 2\text{-}1\text{-}2$$

Therefore, qualitatively, the additional field is expressed as

$$E_s = V \times \frac{V}{C^2} \times E$$

Quantitatively, the additional field is expressed as

$$E_{ss} = \frac{q}{4\pi\varepsilon_0 r^2} \cdot \frac{(1-\frac{V^2}{C^2})}{(1-\frac{V^2\sin^2\theta'}{C^2})^{3/2}}$$

$$= E(1-\frac{V^2}{C^2}\sin^2\theta')^{-1/2}$$

$$\approx E + \left(\frac{1}{2}\frac{V^2}{C^2}\sin^2\theta'\right)E \qquad 2\text{-}1\text{-}3$$

However, the approximate additional field can also be expressed quantitatively as

$$E_s \approx \frac{1}{2}\frac{V^2}{C^2}\sin^2\theta'\mathrm{E} \qquad 2\text{-}1\text{-}4$$

This is none other than the relativistic effect by the *K* factor from special relativity:

$$K = \frac{1}{\sqrt{1-\frac{V^2}{c^2}}}E \qquad 2\text{-}1\text{-}5$$

Because of special relativity, the factors of gravitational force should be changed (function of velocity) when the mass change is very small. That is

$$F = ma \rightarrow\ F = \frac{m}{\sqrt{1-\frac{u^2}{C^2}}}\left[a + \frac{u(u\cdot a)}{(c^2-u^2)}\right] \qquad 2\text{-}1\text{-}6$$

However, according to CFLE theory (cf. *Curved Forced Line Elements Theory*, Revised Ed. [hereinafter *CFLE Theory*], §5), the gravitational force can be described as

$$F = m(\mathbb{E} + v \times \mathbb{B}) \qquad 2\text{-}1\text{-}7$$

$$\mathbb{B} = \frac{V}{C^2} \times \mathbb{E} \qquad 2\text{-}1\text{-}8$$

where $\mathbb{E}$ is the gravitational field and $\mathbb{B}$ is the gravitomagnetic field.

Therefore, qualitatively, the additional field is

$$\mathbb{E}_s = V \times \frac{V}{C^2} \times \mathbb{E} \qquad 2\text{-}1\text{-}9$$

However, quantitatively, the approximate additional field can be by

$$\mathbb{E}_s \approx \frac{1}{2}\frac{V^2}{C^2}\sin^2\theta'\mathbb{E} \qquad 2\text{-}1\text{-}10$$

Again, this is the relativistic effect by the *K* factor from special relativity:

$$K = \frac{1}{\sqrt{1-\frac{V^2}{c^2}}}\,\mathbb{E} \qquad 2\text{-}1\text{-}11$$

Now we can apply Eq. 2-1-10 to flyby anomalies, when $\frac{V^2}{C^2}$ is much smaller than 1.

Because the speed of Galileo 1 at infinity was $V = 8.949\times 10^3$ m/s, the additional effect by special relativity is

$$E_A \approx \frac{1}{2}\left(\frac{8.949\times10^3}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{80.0846\times10^6}{8.988\times10^{16}}\right) \approx 4.455\times10^{-10} \qquad 2\text{-}1\text{-}12$$

However, the curved force line factor g = 6.546550 (cf. *CFLE Theory*, §7.6:) of Earth's magnetic field that is produced by neutron mass (cf. *CFLE Theory*, §5) makes a much stronger additional effect. Even though gravitational force is 10^{40} weaker than the electromagnetic force, because of Earth's huge mass, Earth's related magnetic field strength is *B* = 0.3G.

In other words, Earth's gravitational force strength reaches the electromagnetic force strength on account of Earth's huge mass. Therefore, the permitted maximum curved force line factor reached should be the same as the curve degree of a neutron's force line in order to produce a magnetic field of *B* = 0.3G. That is

$$E_{Ag} = g^2_{\text{force}}$$

$$= (6.546550)^2 \qquad 2\text{-}1\text{-}13$$

where g^2_{force} is the curved force line factor g of distant "*r*" from $F = \frac{Gm^2}{r^2}$ and $F = \frac{e^2}{4\mu\varepsilon_0 r^2}$

The total effect by the curved force line factor by $\frac{V^2}{C^2}$ is

$$E_{Ag} = \frac{V^2}{1^2}$$

$= [\ g_{\text{force}}^{2}\ ]^{2}$

$= [(6.546550)^{2}\ ]^{2}$

≈ 1837 2-1-14

where 1^{2} is the value of the flat force line.

Therefore, all of the additional interacting strength between Earth's magnetic field and the space craft's gravitational force is

$$E_{Agt} \approx (4.455 \times 10^{-10})\ (1.837 \times 10^{3}) \approx 8.184 \times 10^{-7} \qquad 2\text{-}1\text{-}15$$

With Galileo 1's speed in mm/s being $V = 8.949 \times 10^{6}$mm/s, the possible maximum additional speed from the craft interacting with Earth's magnetic field is

$V_{\text{add}} \approx (8.184 \times 10^{-7})\ (8.949 \times 10^{6}$ mm/s)

≈ 7.324 mm/s 2-1-16

However, because the composition ratio (*R*) of Earth's material and the space craft's material is approximately that of a proton:neutron = 1:1, the real additional speed is

$$V_{\text{add}} \approx \frac{7.324\ \text{mm/s}}{2}$$

≈ 3.662 mm/s 2-1-17

Because, the gravitational permittivity of Earth in the altitude of free space is free (cf. *CFLE Theory*, §10), the effective additional speed increment by Earth's gravitational permittivity is

V $\approx$ (3.662 mm/s) (1.073176)

≈ 3.930 mm/s 2-1-18

Likewise, because the electrical permittivity of air at $g = 1.5$ (cf. *CFLE Theory*, §7, §10) in the altitude of free space is also free, the effective additional speed is

$Q = (0.000589)(2)(1.5) = 0.001178, \qquad x = 1.001767$ 2-1-19

$$V_{\text{add}} \approx \frac{3.930\ \text{mm/s}}{1.001767}$$

$$\approx 3.923\ \text{mm/s} \qquad \text{2-1-20}$$

That is the speed increment of Galileo 1 at infinity (where the "2" of Eq. 2-1-19 is from Eq. 2-1-17).

The observed speed increment of Galileo 1 at infinity by J. D. Anderson and colleagues was

$V_{\text{add}} = 3.92 \pm 0.08$ mm/s 2-1-21

We find here that the theoretical value calculated by CFLE theory agrees quite well with the observed value.

Galileo 1's angle between the trajectory of the ground track and the equator was

$\theta = 142.9°$ 2-1-22

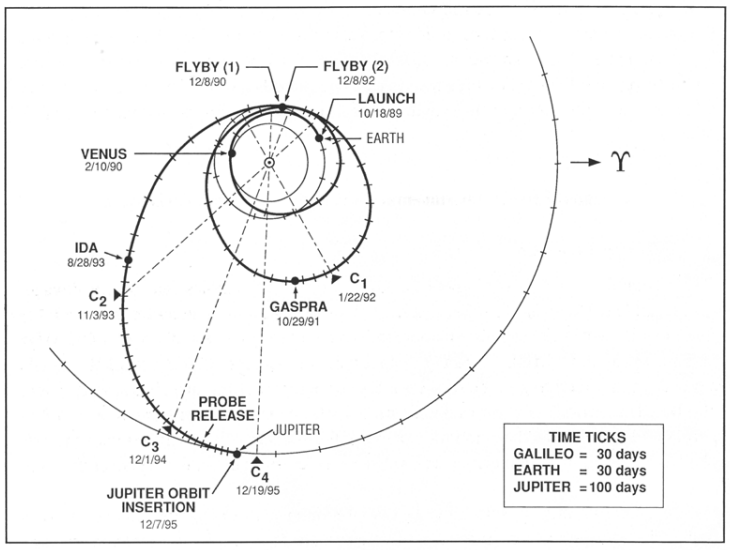

Figure 2-1-2. Galileo's trajectory
(Source: Courtesy NASA)

At this angle (θ =142.9°) of Galileo 1, the mass magnet of the space craft cannot interact with Earth's magnetic field, because the angle of the gravitomagnetic field for Galileo 1, called the rest angle, is

$$\theta_{\text{rest}} = 142.9° - 90°$$

$$= 52.90° \qquad \text{2-1-23}$$

The angle between magnetic north and the rotational axis of Earth or the space craft, called the north magnet angle, is

$$\theta_{\text{north magnet}} = 10.54° \qquad \text{2-1-24}$$

Likewise, the angle between magnetic south and the rotational axis of Earth's or the space craft's magnetic south, called the magnetic south angle, is

$$\theta_{\text{south magnet}} = 27.14° \qquad \text{2-1-25}$$

The total angle ($\sin^2\theta'$) between the space craft and Earth is called the action angle, and is

$$\theta'_{\text{action}} = [(52.90°) + (10.54°) + (27.14°)]\ (1)$$

$$= 90.58° \approx 90° \qquad \text{2-1-26}$$

Because $\sin(90^o) = 1$, in the case of Galileo 1, there cannot exist the effect from the action angle by the process between

$$\mathbb{E}_s = V \times \frac{V}{C^2} \times \mathbb{E}\ \text{(Vector)} \quad \leftrightarrow \quad \mathbb{E}_s \approx \frac{1}{2}\frac{V^2}{C^2}\sin^2\theta'\mathbb{E}\ \text{(Scalar)} \qquad \text{2-1-27}$$

Regarding the additional speed increment at perigee, the speed of Galileo 1 at perigee was

$$V = 1.3738 \times 10^4 \text{m/s} \qquad \text{2-1-28}$$

The additional effect by special relativity is

$$E_A \approx \frac{1}{2}\left(\frac{1.374\times10^4}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{1.888\times10^8}{8.988\times10^{16}}\right) \approx 1.050 \times 10^{-9} \qquad \text{2-1-29}$$

The additional effect by the curved force line factor g^2_{force} is

$$E_{Ag} = \frac{V^2}{1^2}$$

$$= [g^2_{\text{force}}]^2$$

$$= [(6.546550)^2]^2$$

$$\approx 1837 \qquad \text{2-1-30}$$

Therefore, all of additional interacting strength between Earth's magnetic field and the satellite's gravitational force is

$$E_{Agt} \approx (1.050 \times 10^{-9})(1.837 \times 10^3)$$

$$\approx 1.929 \times 10^{-6} \qquad \text{2-1-31}$$

Because speed of Galileo 1 at perigee is $V = 1.374 \times 10^7$ mm/s, its possible maximum additional speed by interacting with Earth's magnetic field is

$$V_{\text{add}} \approx (1.929 \times 10^{-6})\ (1.374 \times 10^7 \text{ mm/s})$$

$$\approx 26.50 \text{ mm/s} \qquad \text{2-1-32}$$

Because of the composition factor "2" of Eq. 2-1-17,

$$V_{add} \approx \frac{26.50 \text{ mm/s}}{2}$$

$$\approx 13.25 \text{ mm/s} \qquad \text{2-1-33}$$

Taking into account the effect at perigee of the theoretical angle (10.54°) between Earth's magnetic north and its rotational pole (cf. *CFLE Theory*, §5-3)

$$\sin\theta = \frac{1.464}{8}$$

$$= 0.183$$

$\sin(10.54^o) = 0.183$

Therefore, $\theta = 10.54° \approx 11°$ 2-1-34

The effective speed increment is

$V_{\text{add}} \approx (13.25 \text{ mm/s})\ (0.183)$

$\approx 2.425 \text{ mm/s}$ 2-1-35

Using the same rationale as used above in Eq. 2-1-18, in the altitude of free space, the effective additional speed increment difference by Earth's gravitational permittivity is

$V_{\text{add}} \approx (2.425 \text{ mm/s})\ (1.073176)$

$\approx 2.602 \text{ mm/s}$ 2-1-36

Likewise, taking into account the electrical permittivity at $g = 1.5$ of free space, the effective additional speed by the factor $x = 1.001767$ (cf. Eq. 2-1-19) is

$V_{\text{add}} \approx \frac{2.602 \text{ mm/s}}{1.001767}$

$\approx 2.597 \text{ mm/s}$ 2-1-37

Given Galileo 1's angle of 142.9° between the trajectory of ground track and the equator, the rest angle for the space craft is

$\theta_{\text{rest}} = 142.9° - 90° = 52.90°$ 2-1-38

and its north magnet angle ($\theta_{\text{north magnet}}$) is 10.54°.

Because the expected magnetic south angle ($\theta_{\text{south magnet}}$) of the space craft is also 10.54°, the effective action angle of the space craft is

$\theta_{\text{effective}} = 52.90° + 10.54° + 10.54° = 73.98°$

$d = \frac{1}{\sin(73.98°)} = 1.040$ 2-1-39

Finally, the action angle $sin^2\theta'$ between the space craft and Earth is

θ'_{action} = [(52.90°) + (24.14°) + (0)] (1.040) = 83.24°

where "0" is the expected proper north magnetic pole angle of Galileo 1 by the effect of (0 × 90°).

To satisfy going from

$\mathbb{E}_s = V \times \frac{V}{C^2} \times \mathbb{E}$ (Vector) to $\mathbb{E}_s \approx \frac{1}{2}\frac{V^2}{C^2} \sin^2\theta' \mathbb{E}$ (Scalar)

$d = \sin^2(83.24°) = 0.986$ 2-1-40

Therefore, the theoretical value of the speed increment for Galileo 1 is

$V_{\text{theoretical}} \approx (2.597 \text{ mm/s})(0.986)$

≈ 2.561 mm/s 2-1-41

The observed speed increment of Galileo 1 at perigee was

$V_{\text{add}} = 2.56 \pm 0.05$ mm/s 2-1-42

Once again, the theoretical value agrees well with the observed value.

This good agreement gives encourages us to investigate other flyby anomalies using the general relativity of CFLE Theory.

2.2. Establishing the theoretical angle between Earth's rotational axis and Earth's magnetic South Pole

The ratio between the strong force and the electromagnetic force is

R_F = 92:238.03

= 1:2.587 2-2-1

where 238.03 is the maximum number of neutrons and protons in uranium as permitted by nature, and 92 is the maximum number of electrons or protons.

Therefore, the maximum allowed strong force strength in the uranium nucleus is

$$F_{\text{strong}} = 2.587\ F_{\text{electric}} \qquad \text{2-2-2}$$

Because the strong force is the primary reason for Earth' mass (cf. *CFLE Theory*, §5) and its related gravitomagnetic force, the maximum excited-state energy level for a neutron in the nucleus is

$$E_{\text{excite}} = 2.587\ E_{\text{bound}} \qquad \text{2-2-3}$$

However, Earth's magnetic South Pole is a force line donator (cf. *CFLE Theory*, §5), much like the charge and mass of a positively charged particle are 1836 times bigger than that of a negatively charged particle.

Therefore, the theoretical maximum South Pole angle is

$$\theta_{\text{south}} = 2.587\ \theta_{\text{north}}$$

$$= (2.587)\ (10.54°)$$

$$= 27.27° \qquad \text{2-2-4}$$

However, upon changing from the electrical force strength to the strong force strength, with the change of the force line gradient going from $g = 1$ to $g = 8$, the related electrical permittivity change of the particle is

$$Q = (0.000579)(8) = 0.004632, \qquad x = 1.004632 \qquad \text{2-2-5}$$

The effective maximum angle becomes

$$\theta_{\text{south}} = \frac{27.27°}{1.004632} = 27.14° \qquad \text{2-2-6}$$

Because of the gravitational permittivity of Earth (cf. *CFLE Theory*, §10), the theoretical South Pole angle is

$$\theta_{\text{theoretical}} = \frac{27.27^\circ}{1.073176} = 25.29^\circ \qquad 2\text{-}2\text{-}7$$

The observed angle between the magnetic South Pole and the rotational axis by the Geological Survey of Canada on 2001 (cf. *CFLE Theory*, §5.3) was

$$\theta_{\text{observed}} = 25.30^\circ \qquad 2\text{-}2\text{-}8$$

giving the observed position of the magnetic South Pole in 2001 as

$$P_{\text{observed}} = [64.70^\circ \text{ S}, 138.00^\circ \text{ E}] \qquad 2\text{-}2\text{-}9$$

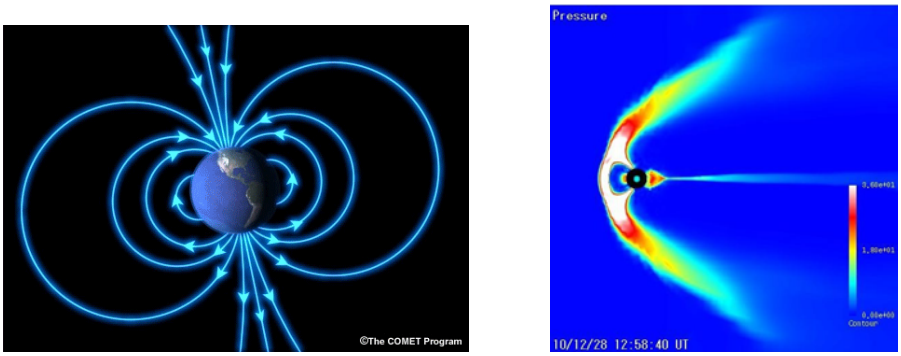

Figure 2-2-1. Earth's magnetic field and the unusual activity of Earth's magnetosphere
(Source: Courtesy Windows to The Universe)

2.3. NEAR

Figure 2-3-1. NEAR: the Near Earth Asteroid Rendevous space craft
(Source: Courtesy NASA)

The calculations of CFLE theory parameters for NEAR and Cassini (§2.4) are exactly the same as those used for Galileo 1 above (cf. §2.1), the only variables being the speeds and angles of the respective space craft. Therefore, only calculations pertinent to the space craft under discussion are presented below.

The speed at infinity of the space craft NEAR is $V = 6.851 \times 10^3$ m/s, giving the additional effect by special relativity as

$$E_A \approx \frac{1}{2}\left(\frac{6.851\times10^3}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{46.936\times10^6}{8.988\times10^{16}}\right) \approx 2.611 \times 10^{-10} \qquad \text{2-3-1}$$

However, as discussed in §2.1 and calculated in Eqs. 2-1-13 and 2-1-14 above, the curved force line factor $g = 6.546550$ of Earth's magnetic field produces a stronger additional effect, resulting in

$$E_{Ag} \approx 1837$$

Therefore all of the additional interacting strength between Earth's magnetic field and the satellite's gravitational force is

$$E_{Agt} \approx (2.611 \times 10^{-10})\,(1.837 \times 10^3) \approx 4.796 \times 10^{-7} \qquad \text{2-3-2}$$

Thus, the possible maximum additional speed of NEAR by interacting with Earth's magnetic field is

$$V_{\text{add}} \approx (4.796 \times 10^{-7})\,(6.851 \times 10^6 \text{ mm/s})$$

$$\approx 3.268 \text{ mm/s} \qquad \text{2-3-3}$$

But, again, given the composition ratio of Earth material to space craft material of 1:1, the real additional speed is

$$V_{\text{add}} \approx \frac{3.268 \text{ mm/s}}{2}$$

$$\approx 1.634 \text{ mm/s} \qquad \text{2-3-4}$$

Taking into account the gravitational permittivity of Earth ($x = 1.073176$) at the altitude of free space, the effective additional speed increment is

$V \approx$(1.634 mm/s) (1.073176)

$\approx$ 1.754 mm/s 2-3-5

Taking further account of the electrical permittivity (x = 1.001767; cf. Eq. 2-1-19) of air in free space, the effective additional speed is

$$V_{\text{add}} \approx \frac{1.754 \text{ mm/s}}{1.001767}$$

$\approx$ 1.751 mm/s 2-3-6

Given the angle of 108.8° between the trajectory of NEAR and Earth's equator, the rest angle between Earth and the space craft is

θ_{rest} = 108.8° – 90°

= 18.8° 2-3-7

The rest angle between NEAR's trajectory and Earth's South Pole is

θ_{rest} = 90° – 27.14°

= 62.86° 2-3-8

$$d = \frac{1}{\sin(62.86°)}$$

= 1.124

The action angle between NEAR and Earth is

θ'_{action} = [(18.8°) + (27.14°) – (27.14°_{N})] (1.124)

= 21.13° 2-3-9

where 27.14°_{N} is the expected proper magnetic North Pole angle of NEAR.

To satisfy the conversion from vector to scalar functions (cf. Eq. 2-1-27) by reverse interaction

$$E_{ff} = \frac{1}{\sin^2(21.13°)}$$

$$= 7.695 \qquad \text{2-3-10}$$

Therefore, the total additional strength for speed increment of NEAR at infinity by Earth's magnetic field is

$$V_{\text{theoretical}} \approx (1.751 \text{ mm/s})\ (7.695)$$

$$\approx 13.47 \text{ mm/s} \qquad \text{2-3-11}$$

This theoretical value agrees well with the observed speed by J. D. Anderson and colleagues, which was

$$V_{\text{observed}} \approx 13.46 \pm 0.13 \text{ mm/s} \qquad \text{2-3-12}$$

Turning our attention now to the additional speed increment of NEAR at perigee, the speed of the space craft at perigee was

$$V = 1.2739 \times 10^4 \text{ m/s} \qquad \text{2-3-13}$$

The additional effect by special relativity is

$$E_A \approx \frac{1}{2}\left(\frac{1.274\times10^4}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{1.623\times10^8}{8.988\times10^{16}}\right) \approx 9.029 \times 10^{-10} \qquad \text{2-3-14}$$

Given $E_{Ag} \approx 1837$ (cf. Eq. 2-1-14),

$$E_{Agt} \approx (9.029 \times 10^{-10})(1.837 \times 10^3)$$

$$\approx 1.659 \times 10^{-6} \qquad \text{2-3-15}$$

Thus, taking into account the composition factor of "2" (cf. Eq. 2-1-17), NEAR's possible maximum additional speed by interacting with Earth's magnetic field is

$$V_{\text{add}} \approx \frac{(1.659 \times 10^{-6})(1.274 \times 10^7 \text{mm/s})}{2}$$

$$\approx 10.57 \text{ mm/s} \qquad \text{2-3-16}$$

With the angle at perigee (10.54°) between Earth's magnetic pole and rotational pole giving sin θ = 0.183 (cf. Eq. 2-1-34), the final speed increment is

$V_{\text{add}} \approx$ (10.57 mm/s) (0.183)

$\approx$1.934 mm/s 2-3-17

Taking into account the gravitational permittivity of Earth as before,

$V_{\text{add}} \approx$ (1.934 mm/s) (1.073176)

$\approx$ 2.076 mm/s 2-3-18

Considering the electrical permittivity at g = 1.5,

$V_{\text{add}} \approx \frac{2.076 \text{ mm/s}}{1.001767}$

$\approx$ 2.072 mm/s 2-3-19

Given the angle between NEAR and Earth's equator is 108.80°, the rest angle between Earth and the space craft is

θ_{rest} = 108.80° – 90° = 18.80°

Therefore, the effective action angle of the space craft is

$\theta_{\text{effective}}$ = 18.80° + 27.14° + 24.24° = 70.18° 2-3-20

$d = \frac{1}{\sin(70.18°)}$ = 1.063

where 24.24° is the expected proper magnetic North Pole angle of NEAR.

The rest angle between the space craft trajectory's and Earth's South Pole is

θ_{rest}= 90° – 27.14° = 62.86°

$$d = \frac{1}{\sin(62.86°)} = 1.124 \qquad 2\text{-}3\text{-}21$$

$$d_{\text{sum}} = (1.063)\,(1.124) = 1.195 \qquad 2\text{-}3\text{-}22$$

The $\sin^2\theta'$ between the space craft and Earth is

$$\theta'_{\text{action}} = [(18.80°) + (27.17°) - (18.80^{o}_{\text{N}})]\,(1.195) = 32.42^{o} \qquad 2\text{-}3\text{-}23$$

where 18.80^{o}_{N} is the expected proper magnetic North Pole angle of NEAR.

Converting the vector to scalar functions,

$$E_{ff} = \frac{1}{\sin^2(32.42°)} = 3.480 \qquad 2\text{-}3\text{-}24$$

Therefore, the expected speed increment at perigee by the angle factor is

$$V_{\text{theoretical}} \approx (2.072 \text{ mm/s})\,(3.480)$$

$$\approx 7.211 \text{ mm/s} \qquad 2\text{-}3\text{-}25$$

This compares favorable with the observed value

$$V_{\text{observed}} = 7.21 \pm 0.07 \text{ mm/s} \qquad 2\text{-}3\text{-}26$$

Figure 2-3-2. Goldstone NASA Deep Space Network
(Source: Courtesy NASA)

2.4. Cassini

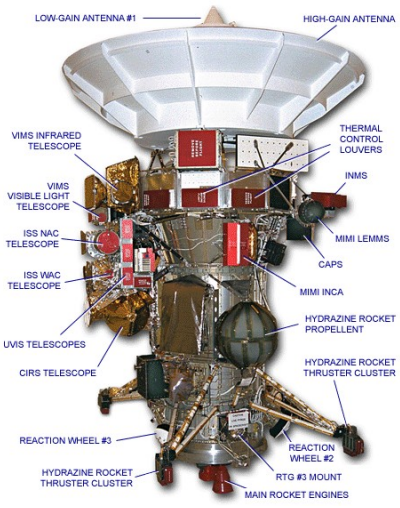

Figure 2-4-1. CASSINI space craft payload
(Source: Courtesy PDS Imaging Node)

In this section, only the results of all the parameters calculated as they pertain to Cassini are presented. To review the steps in the calculations with explanations, please refer to §2.1.

Cassini's speed at infinity is 1.601×10^4 m/s; therefore,

$$E_A \approx \frac{1}{2}\left(\frac{1.601\times10^4}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{25.63\times10^7}{8.988\times10^{16}}\right) \approx 1.426\times 10^{-9} \qquad 2\text{-}4\text{-}1$$

$$E_{Agt} \approx (1.426 \times 10^{-9})(1.837 \times 10^3) \approx 2.620 \times 10^{-6} \qquad 2\text{-}4\text{-}2$$

$$V_{\text{add}} \approx (2.620 \times 10^{-6})\ (1.601 \times 10^7 \text{ mm/s})$$

$$\approx 41.95 \text{ mm/s} \qquad 2\text{-}4\text{-}3$$

which with composition ratio consideration becomes

$$V_{\text{add}} \approx \frac{41.95\text{mm/s}}{2} \approx 20.98 \text{ mm/s} \qquad 2\text{-}4\text{-}4$$

Consideration of the gravitational permittivity of Earth and electrical permittivity of air at free space altitude gives, respectively,

$$V_{\text{add}} \approx (20.98 \text{ mm/s})\ (1.073176)$$

$$\approx 22.52 \text{ mm/s} \qquad 2\text{-}4\text{-}5$$

and

$$V_{\text{add}} \approx \frac{22.52 \text{ mm/s}}{1.001767} \approx 22.48 \text{ mm/s} \quad \text{2-4-6}$$

The angle (10.54°) effect at perigee gives

$$V_{\text{add}} \approx (22.48 \text{ mm/s})\ (0.183) \approx 4.114 \text{ mm/s} \quad \text{2-4-7}$$

Earth's magnetic South Pole angle of 27.14° influences the speed of Cassini by as much as

$$E_{ff} = \frac{1}{\sin(27.14°)} = 2.192$$

Thus, the additional speed increment by this factor is

$$V_{\text{add}} \approx \frac{4.114 \text{ mm/s}}{2.192} \approx 1.877 \text{ mm/s} \quad \text{2-4-8}$$

Given that the angle between Cassini's trajectory and Earth's equator is 25.40°,

$$\theta_{\text{rest}} = 25.40° - 90° = -64.60° \quad \text{2-4-9}$$

The rest angle between Cassini's trajectory and Earth's South Pole is

$$\theta_{\text{rest}} = 90° - 27.14° = 62.86°$$

Figure 2-4-2. Cassini above Earth, 10 years ago
(Source: Courtesy NASA)

$d = \frac{1}{\sin(62.86°)} = 1.124$

Thus,

$\theta'_{\text{action}} = [(-64.60°) + (10.54°) - (10.54°)]\ (1.124)$

$= -72.61°$

where 10.54° is the expected proper magnetic South Pole angle of Cassini.

$$E_{ff} = \frac{1}{\sin^2(72.61°)} = -1.098 \qquad 2\text{-}4\text{-}10$$

Therefore, the final speed change of Cassini is

$V_{\text{theoretical}} \approx (1.877 \text{ mm/s})\ (-1.098)$

$$\approx -2.061 \text{ mm/s} \qquad 2\text{-}4\text{-}11$$

Cassini's observed speed increment was

$$V_{\text{add}} = -2 \pm 1 \text{ mm/s} \qquad 2\text{-}4\text{-}12$$

With regard to the speed of Cassini at perigee, $V = 1.903 \times 10^4$ m/s,

$$E_A \approx \frac{1}{2}\left(\frac{1.903\times10^4}{2.998\times10^8}\right)^2 \approx \frac{1}{2}\left(\frac{36.21\times10^7}{8.988\times10^{16}}\right) \approx 2.014 \times 10^{-9} \qquad 2\text{-}4\text{-}13$$

giving

$$E_{Agt} \approx (2.014 \times 10^{-9})\ (1.837 \times 10^3) \approx 3.700 \times 10^{-6} \qquad 2\text{-}4\text{-}14$$

This results in

$$V_{\text{add}} \approx (3.700 \times 10^{-6})\ (1.903 \times 10^7 \text{mm/s}) \approx 70.41 \text{ mm/s} \qquad 2\text{-}4\text{-}15$$

Taking into account the composition ratio (2),

$$V_{\text{add}} \approx \frac{70.41 \text{ mm/s}}{2} \approx 35.21 \text{ mm/s} \qquad 2\text{-}4\text{-}16$$

We consider again the gravitational permittivity of Earth and the electrical permittivity of air in the altitude of free space, giving respectively

$$V_{\text{add}} \approx (35.21 \text{ mm/s})\ (1.073176)\ \approx 37.79 \text{ mm/s} \qquad 2\text{-}4\text{-}17$$

and

$$V_{\text{add}} \approx \frac{37.79 \text{ mm/s}}{1.001767} \approx 37.72 \text{ mm/s} \qquad 2\text{-}4\text{-}18$$

The perigee effect angle of 10.54° gives a further effective speed increment as

$$V_{\text{add}} \approx (37.72 \text{ mm/s})\ (0.183) \approx 6.903 \text{ mm/s} \qquad 2\text{-}4\text{-}19$$

Earth's magnetic South Pole factor of

$$E_{ff} = \frac{1}{\sin(27.14°)} = 2.192$$

influences the speed of Cassini by as much as

$$V_{\text{add}} \approx \frac{6.903 \text{ mm/s}}{2.192} \approx 3.149 \text{ mm/s} \qquad 2\text{-}4\text{-}20$$

Taking the angle between Cassini's trajectory Earth's equator as 25.40°, the effective action angle of the space craft is

$$\theta_{\text{effective}} = 25.40° + 27.14° + 0 = 52.54° \qquad 2\text{-}4\text{-}21$$

The rest angle between Cassini's trajectory and Earth's equator is

$$\theta_{\text{rest}} = 25.40° - 90° = -64.60$$

$$d = -\sin(64.60°) = -0.903$$

This gives the action angle between Cassini and Earth as

$$\theta'_{\text{action}} = [(25.40°) + (27.14°) - (0)]\ (-0.903)$$

$$= -47.46° \qquad 2\text{-}4\text{-}22$$

where 0 is the expected proper magnetic North Pole angle of Cassini.

$$E_{ff} = \frac{1}{\sin^2(-47.46°)} = -1.842 \qquad \text{2-4-23}$$

giving the final speed change of Cassini at perigee as

$$V_{\text{theoretical}} \approx \frac{3.149 \text{ mm/s}}{-1.842}$$

$$\approx -1.710 \text{ mm/s} \qquad \text{2-4-24}$$

The observed speed decrement of Cassini at perigee by J. D. Anderson's team was

$$V_{\text{add}} \approx -1.7 \pm 0.9 \text{ mm/s} \qquad \text{2-4-25}$$

In conclusion, this good agreement between CFLE theory and the experiments proves that the work of the DSN is successful and correct. Earth's magnetic field interacts with space craft via force lines, causing the craft to gain or loss energy and speed. Therefore, we can say that the gravitational force is transported by gravitational force lines, in the same way that electrical force is transported by electrical force lines, a concept that M. Faraday (1791–1867) introduced. Consequently, curved space cannot exist as Einstein asserted (Figure 2-4-3), and we should be considering where and how to fix Einstein's mistake?

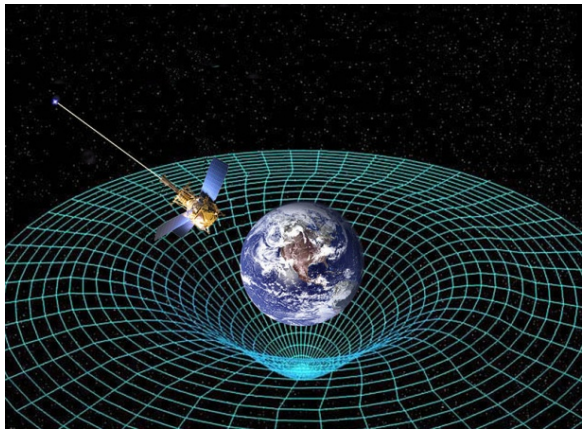

Figure 2-4-3. Artist's rendition of Einsteinian space–time and gravity
(Source: Courtesy NASA)

3. Relation Between Einstein's Equivalence Principle and Curved Space

Albert Einstein observed that bodies accelerated toward the center of Earth at a rate of 1*g* (or 9.81 m/s^2), the standard gravitational acceleration equivalent to that of an inertially moving body observed on a rocket in free space. In 1907, Einstein established the assumption of "complete physical equivalence" between the gravitational field and a corresponding acceleration of a reference system. This became known as the equivalence principle.

In 1911, Einstein developed the idea of two frames of references: one was a uniform gravitational field, named K; the other, named K', had no gravitational field but was uniformly accelerated such that objects in the two reference frames would experience the identical force. Again, Einstein assumed both reference systems to be "physically exactly equivalent," whereby K in a space free from gravitational fields would also be uniformly accelerated. In his own words

> "This assumption of exact physical equivalence makes it impossible for us to speak of the absolute acceleration of the system of reference, just as the usual theory of relativity forbids us to talk of the absolute velocity of a system; and it makes the equal falling of all bodies in a gravitational field seem a matter of course." [1]

Einstein went further to suggest that the total physical equivalence of systems K and K', where the laws of nature with respect to K are in complete agreement with those with respect to K', would not be significant if restricted only to Newtonian mechanics. Instead, this principle had to apply also to optics and all electromagnetic and other universal phenomena.

This idea sowed the seeds for Einstein's theory of general relativity.

1. Excerpt from Einstein, Albert. 1911. "Über den Einfluß der Schwerkraft auf die Ausbreitung des Lichtes," *Annalen der Physik* **35**.

Figure 3-1 shows this situation clearly.

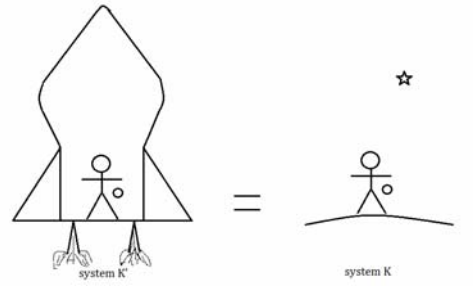

Figure 3-1

Einstein combined the equivalence principle with his special relativity theory to predict the bending of light rays in a Sun's gravitational field and the precession of Mercury's orbit. After the success of these predictions (cf. *CFLE Theory*, §1), he concluded that space–time is curved by gravity. This means that Einstein blew away, all at once, the classical electromagnetic theories of Oersted, Ampere, Coulomb, Faraday, and Maxwell into empty space.

However, the original equivalence principle as described by Einstein, without any input of special relativity or consideration for an observable object $O_{K"}$ in a system K", concluded that free-fall and inertial motion were physically equivalent. This would mean that the gravitational force for observer O_K in system K, observer $O_{K'}$ in system K', and object $O_{K"}$ in system K" is only $F = mg$.

Figure 3-2 shows a simple schematic of Einstein's his principle and the successful prediction of the bending of light rays.

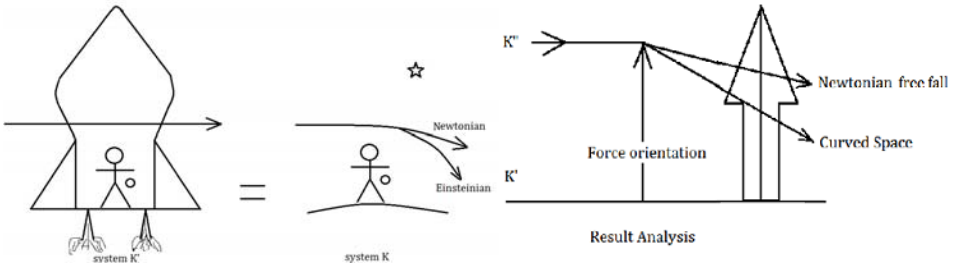

Figure 3-2

In this situation, the relative movement of the Y component for observer $O_{K"}$ in system K" (Eq. 2-1-19 and 2-1-20 cited below are from *CFLE Theory*, §2.1) is

$$U_{K"y} = dv\sqrt{1-\frac{V^2}{C^2}} = dv \cdot 0 = 0 \qquad 2\text{-}1\text{-}19$$

The relative movement for observer $O_{K'}$ in system K' is

$$U_{K'y} = -dv \qquad 2\text{-}1\text{-}20$$

By combining his equivalence principle with special relativity, Einstein rendered his principle inconsistent, because he had not considered the relation with object $O_{K"}$ in system K" under the condition of special relativity. That is, for object $O_{K"}$ in system K", the gravitational force of system K' is very different. Under the new special relativity concept, a rocket of system K' now moves with an acceleration of $a = K_{K'}$ and the moment velocity for object $O_{K"}$ in system K" is $v = v_{\text{moment}}$. According to special relativity, for object $O_{K"}$ in system K", the inertial force of K' is observed when the mass change is very small:

$$F = \frac{m}{\sqrt{1-\frac{u^2}{c^2}}}\left[a + \frac{u(u\cdot a)}{(c^2-u^2)}\right] \qquad 3\text{-}1$$

$$= m\,(\mathbb{E} + u\mathbb{B}) \qquad 3\text{-}2$$

where $a = \frac{du}{dt}$. This force is none other than the gravitational Lorentz force $F = Q\,(E + vB)$ according to CFLE theory. If the mass change of system K' is large, the final force change will be $F = ma + \frac{dm}{dt}v$. But the gravitational force for observer K' is now only

$$F = mg \qquad 3\text{-}3$$

where $g = \frac{GM}{r^2}$, and G is the Newtonian constant. Because a mass magnet or gravitomagnet ($\nabla \times \mathbb{B}$) is now produced by special relativity, the inertial mass and gravitational mass are not

equivalent for object K" in system K", or the gravitational field is not equivalent to the corresponding acceleration of the reference system. This means Einstein's equivalence principle is incorrect and cannot be allowed to be a general principle. That is

$m \neq m + \frac{dm}{dt} \Longrightarrow$ gravitational mass and inertial mass are not the same 3-4

$g \neq [a + \frac{u(u \cdot a)}{(c^2 - u^2)}] / [\sqrt{1 - \frac{u^2}{c^2}}] \Longrightarrow$ gravitational field and acceleration of the reference system are not the same 3-5

Figure 3-3 is a simple schematic of this situation.

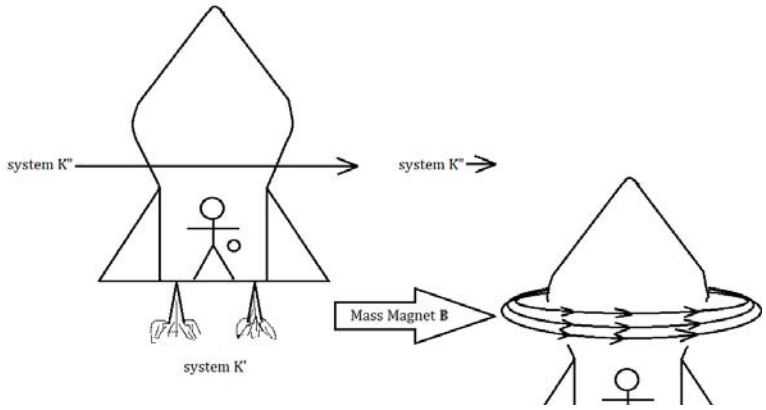

Figure 3-3

But this result is not all. Because system K' is now accelerated for object K", the curl of the mass magnet ($\nabla \times \mathbb{B}$) must be one more curl according to the corresponding Maxwell electrodynamics for electromagnetic wave radiation.

$$\nabla \times (\nabla \times B) = \nabla(\nabla \cdot B) - \nabla^2 B = -\mu_o \varepsilon_o \frac{\partial^2 B}{\partial t^2} \quad 3\text{-}6$$

The corresponding gravitomagnetic wave radiation situation of Figure 3-3 is changed as

$$\nabla \times (\nabla \times \mathbb{B}) = \nabla(\nabla \cdot \mathbb{B}) - \nabla^2 \mathbb{B} = -\frac{1}{G_o I_o} \frac{\partial^2 \mathbb{B}}{\partial t^2} \quad 3\text{-}7$$

Because of this curl $\nabla \times (\nabla \times \mathbb{B})$, the rocket in system K' is curved as shown in Figure 3-4.

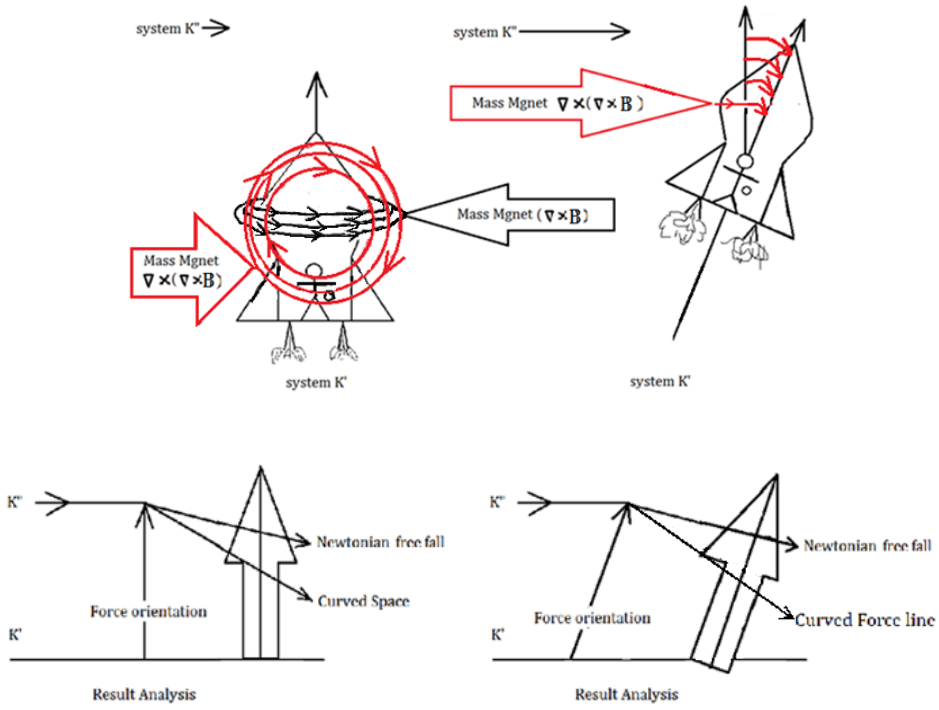

Figure 3-4

In this situation, the relative movement of the Y component for observer $O_{K"}$ in system K" (the equations cited below are from *CFLE Theory*, §3.2) is

$$U_{K"y} = dv\sqrt{1-\frac{V^2}{C^2}}\alpha = dv \cdot \sqrt{\left|\frac{\hbar}{C}\right|} \neq 0 \qquad 3\text{-}2\text{-}18$$

The relative movement for observer $O_{K'}$ in system K' is

$$U_{K'y} = -dv \qquad 3\text{-}2\text{-}17$$

Because of this last curl of system K', object K" is observed by K' as being more curved. According to the last curl of system K' and Eq. 3-2-18, the essence of further falling cannot be by curved space, but instead it must be by a curved rocket or a curved force line.

Therefore, because the equivalence principle is incorrect, the related space–time is not curved. This fact tells us that gravitational force is transported by gravitational force lines and their elements. The flyby anomaly that J. D Anderson and colleagues observed is good evidence about this fact (cf. *CFLE Theory*, §5). Because gravitational force is transported by gravitational force lines, extra dimensions cannot be used to describe any kind of force (gravitational force, weak force, electromagnetic force, and strong force). In conclusion, Einstein's equivalence principle is incorrect.

4. Relation Between the Theory of Curved Space and Renormalization

Because curved space theory does not consider the gravitational polarization phenomenon by mass monopoles (gravitational dipole), this theory cannot use the charge screening technique for renormalization as quantum electrodynamics and quantum chromodynamics. Thus, such renormalization is called dipolar renormalization. Without dipolar renormalization, no theory can be truly compatible with quantum theory. Therefore, at present, any extra-dimensional connection to curved space theory from Einstein's general relativity cannot achieve dipolar renormalization. This means that infinity from curved space will have to be a constant presence during the quantization of gravity; therefore, it is impossible to have a gravitational quantum theory.

5. Relation Between Charge Screening Theory and String Theory

In extra-dimensional theory, the so-called String is applied to overcome the unavoidable effect of infinity. But the essence of infinity is caused only by the K factor of special relativity. When this inconsistency is corrected (cf. *CFLE Theory*, §3), we need no longer worry about infinity (cf. *CFLE Theory*, §3) arising from point-like particles in charge screening theory. According to the special relativity of CFLE theory, there are no point-like particles and string-like particles in nature (cf. *CFLE Theory*, §3.§18). Therefore, both physically and mathematically, the String as a

particle is not needed in any field of physics (cf. *CFLE Theory*, §4 and §18).

> "Maybe there's a way of wrapping up six of the dimensions. Yes, that's possible mathematically, but why not seven?[…] There's no reason whatsoever in superstring theory that it isn't eight of the ten dimensions that get wrapped up and that the result is only two dimensions, which would be completely in disagreement with experience."
>
> Richard Feynman (1918–1988)

6. Relation Between the Accelerating Expansion of the Universe and Gravitational Monopoles

The fact that the Universe is undergoing accelerating expansion, as proven by Saul Perlmutter (2011 Nobel laureate in Physics), is proof that gravitational monopoles can exist (cf. *CFLE Theory*, §13). According to CFLE theory, the accelerating expansion of the Universe can occur by gravitational monopoles and related inertial interactions (cf. *CFLE Theory*, §14), which go on to support the existence of the related gravitational charge screening (gravitational charge shielding) and antigravity. The further existence of mass monopoles, mass conservation laws, pair annihilation (creation) and related gravitational energy conservation laws as simple electric charge conservation laws, pair annihilation (creation) and related electric energy conservation laws can exist naturally without serious logical defects.

Because many scientists believe Einstein's equivalence principle and general relativity, they expect a decelerating expansion of the Universe. However, that is only the motion of tossed objects and freefall by positive gravitational mass. The accelerating expansion of the Universe should only involve the motion of tossed objects and anti-freefall by negative gravitational mass, as predicted by George Gamow (1904–1968) predicted:

> "One can say, however, that if a future experiment should show that antiparticles have a negative gravitational mass, it would

> deliver a painful blow to the entire theory of gravity by disproving the principle of equivalence. In fact, if an observer inside an accelerated Einstein chamber released an apple having a negative gravitational mass, the apple would 'fall upward' (in respect to the space ship), and, as observer from outside, would move with an acceleration twice that of the space ship without being subject any outside forces."

Here "the apple" that would "fall upward" is none other than the corresponding accelerating expansion of the Universe, and the "future experiment" was none other than the I_a supernova observed by Saul Perlmutter.

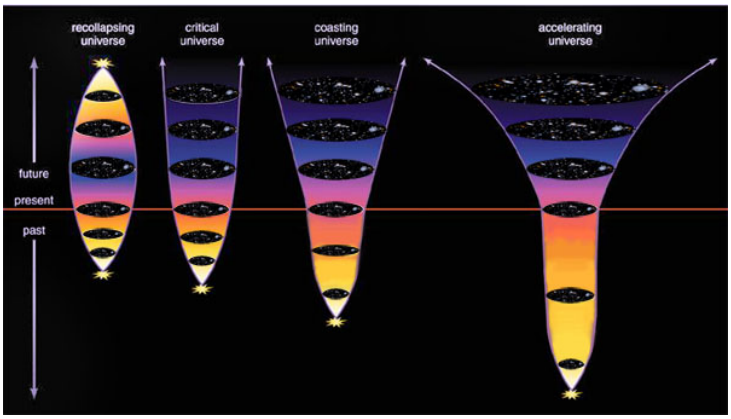

Figure 6-1. The Universe is accelerating
(Source: scienceblogs.com)

7. The Historical Road to Extra-dimensional Theory

After blowing all of classical electrodynamics at once into empty space, Einstein expected a new start of a more revolutionary physics from his concept of curved space. Instead, classical electrodynamics fused into the quantum mechanics and quantum electrodynamics formulated by P.A.M Dirac in 1928, some claims of which (e.g., causality) Einstein clearly rejected, leading to his infamous quotation "My God does not play dice." By 1939, Einstein was such a powerfully influential figure that his signature alone on the Einstein-Szilárd letter was enough to convince President Franklin D. Roosevelt to initiate the Manhattan Project. His scientific assertions claimed absolute authority and many dared not question his brilliance, rendering him to be hailed as *the*

greatest scientist in modern history. The many defenders of quantum mechanics could only be vindicated if Einstein himself finally conceded the logical consistency of the quantum theory and its agreement with experimental facts. This did not happen, as he remained unconvinced up until his death in 1955. And yet, ironically, he also had to face the realization that he could not unify gravity and electricity with curved spaced theory.

In spite of that significant flaw, physicists could not even imagine to criticize Einstein's general relativity. After all, in the early 1960s, general relativity had so little connection with the rest of physics and astronomy that any skeptics of his theory were quite sparsely spread in the physics community. But any skeptical idea at that time would not be given the chance to be fully fleshed out, because the discovery of quasars in 1960 by Thomas Matthews and Allan Sandage thrust general relativity immediately to the forefront of astronomy. The high-energy quasar phenomenon represented a new collapsed state of matter that, at that time, was believed could be described only by the Einstein's general theory of relativity. Therefore, Einstein's relativity was fixed as being "beyond a shadow of a doubt." By such absolute authority and imminent situation were scientist driven to sophistry (cf. §18), sowing the seeds of so-called extra-dimensional theory as being the "theory of everything." But the results of this denial would be the long lists of unsolved problems in physics.

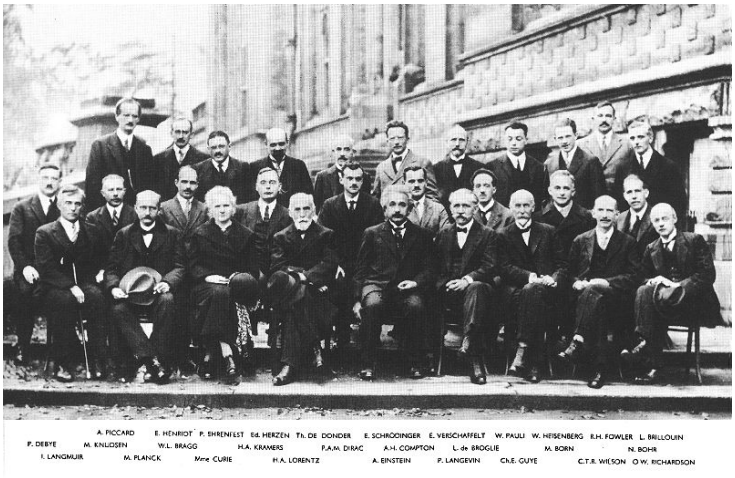

Figure 7-1. Solvay Conference on Quantum Mechanics, 1927.
Einstein is seated front and center, a reveal of his high stature and authority among his peers. Directly behind him, to the left, is Paul Dirac.
(Source: http://w3.pppl.gov/~hammett/courses/gpp1/intro/solvay1927.html)

8. Conclusion

> "I'm particularly annoyed with my friends, the string theorists, because they cannot say anything about the physical world.[…] I don't know what these string people believe. I don't think they know what to believe since they cannot make contact with low energy …"
>
> Sheldon L. Glashow (1932–)

To solve the long list of unsolved problems in physics, it is clear now that we need a new theory of relativity (cf. *CFLE Theory*, §7∼§18), one that obviates Einstein's equivalence principle and related curved space theory. Because gravitational force lines and mass monopoles with mass magnets exist, validation of the curved force line theory of CFLE general relativity is a matter of course. The Earth flyby anomaly brings us the important evidence of the existence of gravitational force lines and their force line elements, and the CFLE calculations are able to fully and accurately predict the anomalous events. This subsequently means that other forces must be have force lines and force line elements as well, to satisfy gauge symmetry (cf. §5) and complete cosmic consistency.

Therefore, it should be concluded that the extra-dimensional theory, the so-called theory of mathematical metaphysics, is incalculable and unextendable experimentally to the high energy of 10^{27}eV, and is not applicable to any fields of physic and mathematics. Instead, nature has given us force lines and force line elements for each conceivable force, which is applicable to all fields of science.