Warp Drive Propulsion Using Magnetic Fields to Distort Space-Time

OR

First Successful Warp Drive Flight

By John R. Cipolla, Copyright August 14, 2020

Abstract

This analysis provides insight into how magnetic fields may be combined to produce a warp bubble like the **expansion-compression** warp bubble predicted by Alcubierre's solution derived from Einstein's theory of general relativity but without the requirement for **negative energy**. The shape of the magnetic field warp bubble generated by this analysis indicates a subluminal (v < c) type of warp drive propulsion based on magnetic fields may be technically possible. These results are based on the theory that magnetic field forces of attraction and repulsion are a relativistic effect caused by fast moving electrically charged particles that distort space-time. Where, magnetic field forces of attraction and repulsion are a relativistic effect because space-time length contraction in the direction of moving electrons increases the density of charged particles and associated electrical forces. The **expansion** of space-time and the simultaneous **compression** of space-time in regions around intense magnetic fields described here are similar in principle to Alcubierre's superluminal (faster than light) warp drive. This newly defined and simplified mechanism is in fact a true **warp drive.** Where, it is postulated that objects whose **inertia** has been reduced by a magnetic field warp bubble can accelerate to speeds and altitudes greater than similar objects of equivalent mass. As discussed in "*Introducing Physical Warp Drives*" the magnetic field warp bubble proposed in this paper only requires standard methods of propulsion to accelerate. Finally, an experimental device based on the magnetic field warp bubble successfully accelerated a projectile to altitude and speed greater than objects of equivalent mass when accelerated by magnetic-pole to magnetic-pole field orientation.

Nomenclature

B = Magnetic field potential
m_0 = Magnetic Core monopole charge
m_b = Projectile Magnetic monopole charge
μ_0 = Permittivity of free space
i = Current flowing through conductor
d = Distance between charges
X_k = X free field locations
Y_j = Y free field locations
n_{turns} = Number of coils

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Relationship Between Magnetism and Space-Time Distortion

Length contraction is a relativistic effect where objects appear shorter to observers at rest, causing distances between successive points on an object to decrease. For subatomic particles, relativistic effects of moving positive charges i.e., length contraction cause an increase in the relative density of positive charges that increases the imbalance between positive charges and stationary negative charges. Charge imbalance between densely packed moving positive charges and stationary negative charges results in an electric field, **E** in the space around a typical conductor. Where, the electrical current in a wire is defined as the direction positive charges move when an electric field, **E**[1] is applied by an external power source. The mutual attraction between a stream of moving positive charges like in an electrical conductor and a stationary negative test charge is defined by the following equation that relates force and electric field strength.

$$F = -e\,E$$

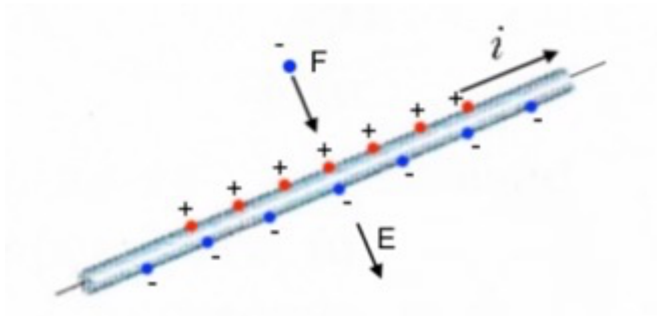

Figure-1, Length contraction effect on a stream of moving positive charges

By changing to an inertial reference frame where the single stationary negative charge moves and the positive charges in the conductor are stationary the following equation for the mutual attraction in a magnetic field, **B**[1] is defined by the following equation.

$$F = -e\,v\;X\;B \qquad (1)$$

Also, according to special relativity, time dilation where clocks appear to tick more slowly to observers at rest fills out our basic understanding of space-time. Therefore, it is postulated that magnetic fields cause the warping of space-time in the general vicinity of a powerful magnet, i.e., at short distances. Furthermore, general relativity[2, 3] states space-time curvature is embodied by the following statement, "Matter-energy tells space-time how to curve and space-time tells matter-energy how to move". The concept of space-time curvature is summarized by the Einstein equation according to general relativity.

$$R_{\mu\nu} - \left({}^{1}/_{2}\right)Rg_{\mu\nu} = (8\pi G)T_{\mu\nu} \qquad (2)$$

According to the Einstein equation, matter and energy tell space-time how to curve and because Equation-2 is an invariant, space-time tells matter and energy how to move. Where, matter and energy are defined by the stress-energy tensor (**T**) and space-time curvature is defined by the Riemann curvature tensor (**R**).

Where, energy is equivalent to mass through the equation, $E = mc^2$. Therefore, magnetic, and electrical fields bend space-time the same way massive objects bend space-time. Also, because space-time is an invariant composed of the invariance between space and time, space-time contraction and expansion using magnetic fields may achieve relative motion in the compressed magnetic field direction for short distances based on the range limitation of magnetic fields. Magnetic field interactions can be described as a purely relativistic phenomenon where magnetic attraction may be described as space-time contraction and magnetic repulsion as space-time expansion. A warp drive propulsion system based on the use of properly oriented magnetic fields compresses space-time and expands space-time to create a region of flat space-time called a **warp bubble**. Properly oriented magnetic fields compress space-time on one side of the vehicle and expand space-time on the opposite side of the vehicle to reduce an object's **inertia** or resistance to acceleration by the concept of space-time **expansion-compression**. The concept of length contraction is predicted by special relativity and general relativity. Over short distances the warp bubble produced by opposing magnetic fields is similar in form to the warp metric predicted by Alcubierre's warp drive solution[4] from general relativity described in the next section.

Alcubierre's Relativistic Warp Bubble Description

According to general relativity, gravity and acceleration are not distinguishable and are caused by the curvature or warp metric of space-time. A warp bubble is a specific warp metric solution of general relativity and is a combination of positive and negative energy fields that pushes and pulls our starship forward to bring our destination to us just like a conveyer belt. The exotic ingredient required to make Alcubierre's warp bubble is negative energy, which has the unusual property of being able to make ordinary matter fall up in a gravitational field. *According to general relativity the space-time behind a warp bubble is **expanded** pushing us to our destination. At the same time the space-time in front of a warp bubble is **compressed** pulling our destination to us.* The compression and expansion process happens in an instant and at many times the speed of light making faster than light travel possible. The combination of positive and negative energy produces an expansion of space behind the bubble and a contraction of space in front of the bubble. In other words, creating space behind the bubble pushes us to our destination and destroying space in front of the bubble pulls us to our destination. This mechanism allows us to travel many times faster than the speed of light relative to the Earth without exceeding the speed of light in our local frame of reference, the warp bubble.

The warp bubble itself is made of fields of positive energy at both ends and a band of negative energy around the middle. These energy fields create huge gravitational effects so powerful the warp bubble can distort space-time without having to accelerate the traveler to achieve faster than light velocity. The main requirement, negative energy also called **vacuum energy** is a property of a vacuum where subatomic particles smaller than an atom dart into and out of existence almost instantaneously. According to the rules of quantum mechanics negative energy creates a negative quantum pressure that propels the warp bubble and therefore our starship forward. An interesting observation is that we may already see the effects of negative energy because astronomers have observed that our universe is expanding due to the presence of dark energy. It is theorized that dark energy fills the vacuum of space between the galaxies and is the cause for the expansion and increasing acceleration of the universe. Figure-2 represents the **relativistic warp bubble** from Alcubierre's solution for a theoretically feasible warp drive propulsion system. This method requires negative energy while the method described in this paper does not.

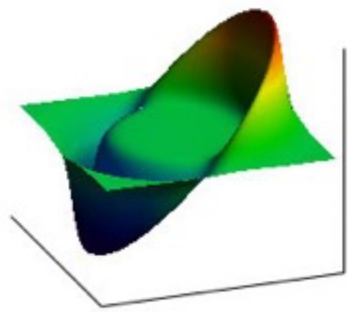

Figure-2, Alcubierre Relativistic Warp Bubble

How The Magnetic Field Warp Drive Works

The magnetic field warp bubble is formed using six charges, three positives and three negatives, arranged as illustrated in Figure-3. Where, each pair of (+/-) charges represent a combination of three magnetic field toroids having north (N) and south (S) magnetic field orientations described in Figure-4a. Figure-4b predicts the maximum magnetic field potential (B) for the “magnetic core” used in this experiment is approximately 7,508 gauss.

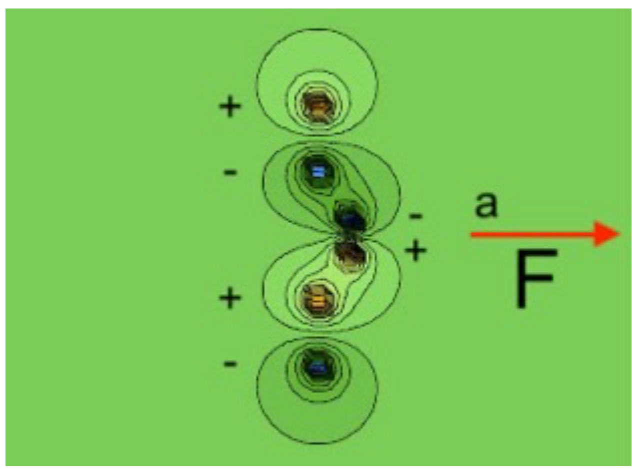

Figure-3, Three magnets form the six-charge warp core

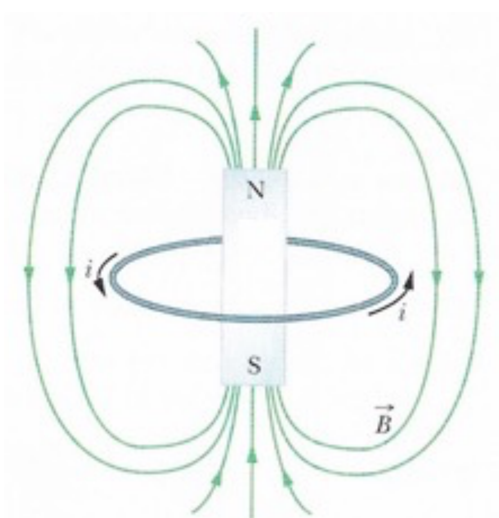

Figure-4a, Toroid electromagnet

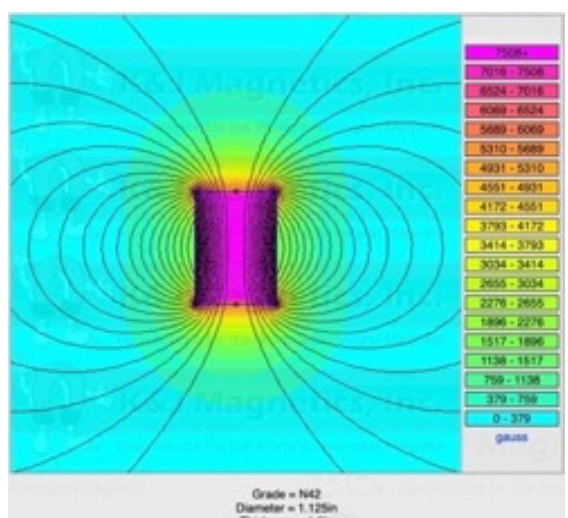

Figure-4b, Magnetic field potential, B

Where, Equation-3 determines the magnetic field potential[1] for six magnetic charges, m_0. The charges are arranged as two point-doublets on each side and two opposing center charges as described in Figure-3 to create a **magnetic field warp bubble**. To create the magnetic field warp bubble described in Figure-5a and Figure-5b the top (+/-) pair forms the first toroid, the middle (-/+) pair forms the second toroid and the lower (+/-) pair forms the third toroid of the **warp core** described in Figure-3, Figure-5a and Figure-5b.

$$B_{k,j} = \frac{\mu_0 i\, n_{turns}}{2\pi}\left[\frac{m_0}{\sqrt{{X_k}^2+\left(Y_j+20\,d\right)^2}}+\frac{-m_0}{\sqrt{{X_k}^2+\left(Y_j+2\,d\right)^2}}+\frac{-m_b}{\sqrt{(X_k+7\,d)^2+\left(Y_j+d\right)^2}}+\frac{m_b}{\sqrt{(X_k+7\,d)^2+\left(Y_j-d\right)^2}}+\frac{m_0}{\sqrt{{X_k}^2+\left(Y_j-2\,d\right)^2}}+\frac{-m_0}{\sqrt{{X_k}^2+\left(Y_j-20\,d\right)^2}}\right] \quad \text{Where } m_0 = 100 \text{ and } m_b = 30 \tag{3}$$

Figure-5a and Figure-5b is the graphical representation of the magnetic field warp bubble derived using Equation-3 and is like Alcubierre's relativistic warp bubble displayed in Figure-2 when the two end magnets in Figure-3 are sufficiently long. As described in Figure-5b mass, **m** experiences velocity, **v** while being influenced by the magnetic field warp bubble described in Figure-5a and Figure-5b. The magnetic field warp bubble is generated using several properly oriented magnetic fields that compress space-time on one side and expand space-time on the opposite side of the warp system as illustrated in Figure-3. In Figure-3 the region between the upper magnet and the lower magnet represents a magnetic field warp bubble, a stable region where an object sits during acceleration and **F** is the force an object in the warp bubble experiences during acceleration, **a**. Figure-3 also describes the field orientation of a three-toroid magnetic field warp bubble used to accelerate the projectile depicted in Figure-6, Figure-7, and Figure-8.

Key Idea: As noted in Figure-5a and Figure-5b, field lines of magnetic energy diverge causing an **expansion** of space-time behind mass, **m**. At the same time, space-time in front of mass, **m** is **compressed**, an effect that shorten distances and compresses space-time. Physical astronomical measurements have confirmed predictions from general relativity that space-time curves around all objects due to variations of mass-energy. This process creates a region of space-time where the **inertial mass** of an object within the warp bubble is reduced allowing for greater than expected velocity and altitude. An experiment that used the magnetic field warp bubble successfully accelerated a projectile to altitude and speed greater than objects of equivalent mass when accelerated by magnetic-pole to magnetic-pole field orientation. This hypothesis was partially verified by a separate experiment that used a "magnetic core" having approximately the same magnetic field intensity to accelerate the same projectile using the magnetic-pole to magnetic-pole method but without the presence of the magnetic field warp bubble.

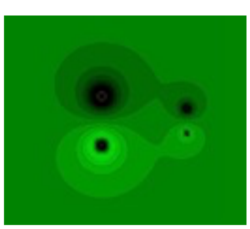
Figure-5a Magnetic field warp bubble

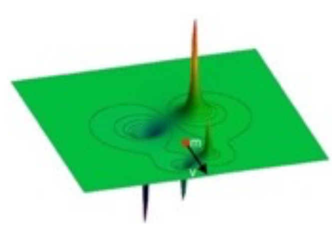
Figure-5b, Space-time expansion-compression

Summary of Basic Supporting Theory

1. **Magnetic field** forces of attraction and repulsion are a **relativistic** effect caused by fast moving electrically charged particles that curve space-time.
2. Powerful magnetic fields like all mass-energy, curve space-time.
3. Space-time curvature is caused by the uneven distribution of mass-energy.
4. The book GRAVITATION[3] proves that gravity waves including the warp bubble postulated here move through space-time as gravitational **quadrupole radiation**[3].
5. The magnetic **warp bubble** described by Equation-3 and displayed in Figure-5a and Figure-5b travel through space-time as gravitational quadrupole radiation that **expands** and **compresses** space-time into the form of a closed **magnetic bubble**.
6. The postulated warp bubble moves through space-time as a subluminal disturbance.
7. Hypothesis and Experiment: Objects whose **inertia** has been reduced by a magnetic field warp bubble can accelerate to speeds and altitudes greater than similar objects of equivalent mass. As discussed in *Introducing Physical Warp Drives*[7] the magnetic field warp bubble proposed in this paper only requires standard methods of propulsion. An experiment that used the magnetic field warp bubble successfully accelerated a projectile to altitude and speed greater than objects of equivalent mass when accelerated by magnetic-pole to magnetic-pole field orientation. This hypothesis was verified by a separate experiment that used a "magnetic core" having approximately the same magnetic field intensity to accelerate the same projectile using the magnetic-pole to magnetic-pole method but without the presence of the magnetic field warp bubble.

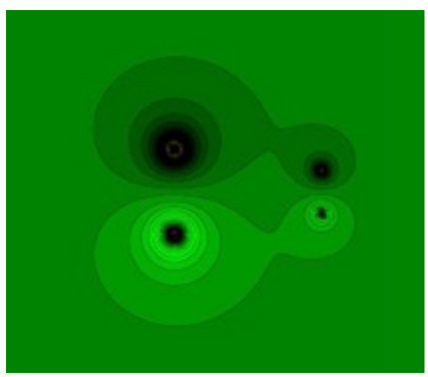

Figure-5a, Magnetic field warp bubble

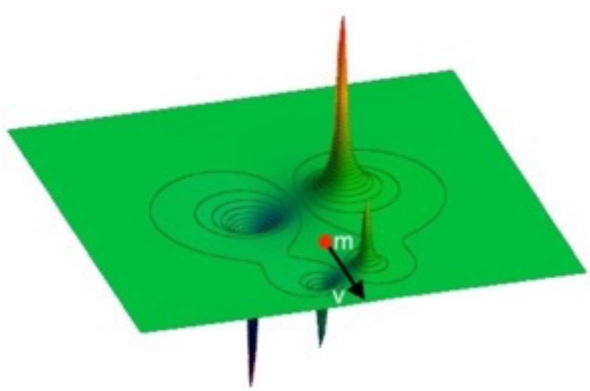

Figure-5b, Space-time expansion-compression

Experiment Demonstrating Space-Time Warping Propulsion

This experiment uses a stack of three magnets modeled as six magnetic field charges whose fields are orientated as described in Figure-3 to accelerate a magnetic field warp drive projectile using the principal of space-time expansion on one side and space-time contraction on the other side. At launch a magnetic projectile described in Figure-6 experiences a force, **F** illustrated in Figure-3 that propels the projectile upward.

Figure-6, Magnetic field warp drive projectile

The magnetic projectile displayed in Figure-7 is held in position between two attracting magnetic stacks by a slender steel rod that extends through a hole at the bottom of the Plexiglas base of the projectile. At launch the slender steel rod is pulled to the right releasing the magnetic projectile allowing the projectile to accelerate 32.0675 cm above the warp core at a launch speed of 2.51 m/sec as illustrated in Figure-8.

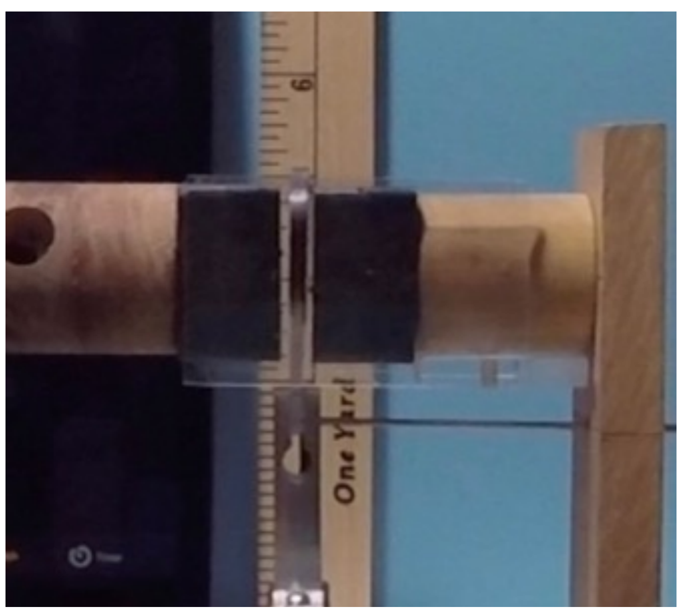

Figure-7, Projectile position immediately before launch

Figure-8, Magnetic field projectile position at apogee

Magnetic Field Projectile Energy and Velocity

From vector mechanics[5] the kinetic energy (T) and potential energy (V) of a magnetically launched projectile at launch (1) and maximum altitude (2) are presented as follows.

$$T_1 = \frac{1}{2} m v_1{}^2, V_1 = 0.0 \quad (4)$$

$$T_2 = 0.0, V_2 = mg\,(h_1 - h_2) \quad (5)$$

We can determine the maximum velocity of a vertically launched projectile by applying the principal of conservation of energy between launch altitude, h_1 and maximum altitude, h_2. At launch (1) the kinetic energy, T_1 of a magnetically launched projectile is greatest and its potential energy, V_1 with respect to gravity is zero. Then, after reaching maximum altitude (2) or apogee the potential energy, V_2 with respect to gravity for a magnetically launched projectile is greatest and its kinetic energy, T_2 is zero.

Initial velocity is determined by equating kinetic energy and potential energy at launch with the kinetic energy and potential energy at maximum altitude and then solving for projectile launch velocity, v_1.

$$T_1 + V_1 = T_2 + V_2 \quad (6)$$

After a little algebra the projectile vertical velocity at launch is the following equation.

$$v_1 = \sqrt{2g(h_2 - h_1)} \quad (7)$$

Magnetic Projectile Trajectory from Launch to Impact

Projectile "x" and "y" location as a function of time, t from launch is determined by the following three numerical equations when aerodynamic drag is neglected.

$$t_n = \frac{n-1}{NMAX-1} T_{max} \tag{8}$$

$$x_n = v_{x0} t_n \tag{9}$$

$$y_n = v_{y0} t_n + \frac{1}{2} g_0 {t_n}^2 \tag{10}$$

Then, projectile maximum horizontal, x and vertical, y locations from launch position.

$$x_{max} = v_{x0} T_{max} \tag{11}$$

$$y_{max} = v_{y0} T_{max} + \frac{1}{2} g_0 {T_{max}}^2 \tag{12}$$

Finally, time to apogee from launch as in Equation-13 and time from apogee to impact as in Equation-14 were derived when aerodynamic drag is neglected.

$$T_{up} = \frac{-v_{y0} + \sqrt{{v_{y0}}^2 + 2 g_0 h_{max}}}{g_0} \tag{13}$$

$$T_{down} = \frac{-v_{y0} - \sqrt{{v_{y0}}^2 + 2 g_0 h_{max}}}{g_0} \tag{14}$$

Table-1 displays experimental results for three launches of the magnetic field projectile described in Figure-6 and Figure-7 to determine time to apogee (0.25 sec) from launch and time from launch to impact (0.54 sec) using high speed video as illustrated in Figure-8 to measure altitude and time increment.

Table-1, Experimental Time of Flight Measurements

Run Number	Clock Time Launch	Clock Time Apogee	Clock Time Impact	Time To Apogee	Time To Impact
1	00:14:08	00:14:33	00:14:62	0.25 sec	0.54 sec
2	00:15:38	00:15:63	00:15:91	0.25 sec	0.53 sec
3	00:09:94	00:10:20	00:10:48	0.26 sec	0.54 sec

Launch velocity computed using Equation-7 is displayed in Table-2 where vertical distance traveled is typically determined using Figure-8 and distance traveled is $h_2 - h_1$.

Table-2, Flight Analysis Results

Launch Velocity	Initial Height, h_1	Final Height, h_2	Apogee Height, $h_2 - h_1$	Apogee Time	Impact Time
2.508 m/sec	4.875 in 12.382 cm	17.50 in 44.45 cm	12.625 in 32.068 cm	0.256 sec	0.511 sec

Magnetic-Pole to Magnetic-Pole Comparison to Warp Bubble Results

The magnetic field warp bubble accelerated the projectile described previously to altitudes and speeds greater than objects of equivalent mass when accelerated by magnetic-pole to magnetic-pole field orientation. This hypothesis was verified by separate experiments presented below that used a "magnetic core" having approximately the same magnetic field intensity, B to accelerate similar projectiles using the magnetic-pole to magnetic-pole method but without the presence of the magnetic warp bubble. Two separate tests were conducted for two separate projectile designs. A series of three tests represented by the projectile depicted in Figure-9a had a mass of 0.690 grams and reached an average maximum altitude of 19.05 cm. A second series of five tests represented by the projectile depicted in Figure-9b had a mass of 0.615 grams and reached an average altitude of 18.29 cm. The maximum altitude attained for the two designs proved that mass had an inverse square law influence on maximum attitude while projectile diameter had a larger influence on maximum altitude. These results are compared to the results described previously where the warp projectile having a mass of 0.475 grams reached an average altitude of 32.07 cm while under the influence of the magnetic field warp bubble. It is hypothesized the greater maximum altitude for the magnetic field warp projectile is due to the reduction of **inertial mass** while under the influence of a **warp bubble**. Conservation of energy would indicate altitude attained should follow the **inverse square law** for all projectiles tested because the magnetic field intensity at launch is nearly identical. The hypothesized magnetic field warp bubble appears to reduce projectile inertial mass allowing the warp drive projectile to attain greater altitude and greater velocity.

Figure-9a, M=0.690 gm, 19.05 cm

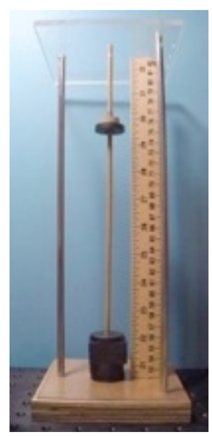

Figure-9b, M=0 .615 grams, Z=18.29 cm

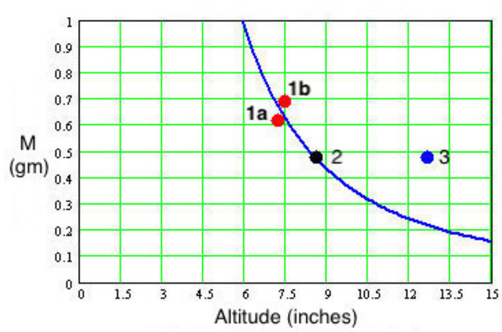

Figure-10, Mass verses altitude, non-warp projectiles (1a, 1b) verses warp projectile (3)

Figure-10 indicates the warp projectile (point-3) does not follow the **inverse square law** for altitude attained as the two projectiles (points 1a, 1b) influenced by the same magnetic core but without the warp bubble. Proof of this assertion is illustrated in graphical form where each dot in Figure-10 represent altitude attained first in the magnetic field without the warp bubble and second the result with the warp bubble. While not conclusive these of tests indicate the warp field hypothesis is correct and that a warp drive device is possible. The altitude for each projectile and significance of the data is described below.

1. The two **red dots**, 1a and 1b in Figure-10 represent attitude attained for magnetic field projectiles accelerated upward without warp bubble influence. These tests are described in this paper as the **magnetic-pole** to **magnetic-pole** altitude tests.
2. The **black dot**, 2 in Figure-10 is the predicted altitude for a projectile having the same mass as the warp projectile but without the influence of the warp bubble. This altitude is predicted using the **inverse square law** for repulsion within a magnetic field, curve-fit from Figure-9a and Figure-9b pole-to-pole data.
3. The **blue dot**, 3 in Figure-10 is the average altitude attained for the magnetic field warp projectile described in section, "*Experiment Demonstrating Space-Time Warping Propulsion*". This data point violates the inverse square law prediction for magnetic field projectiles and indicates a warp bubble may be causing the magnetic field warp projectile to reach greater altitude than predicted by the inverse square law for motion in a magnetic field.

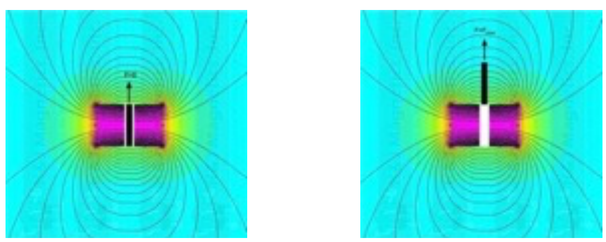

Figure-11, Projectile with warp bubble influence
$F_0 = 0.0$ newtons, $F_1 = 1.28$ newtons

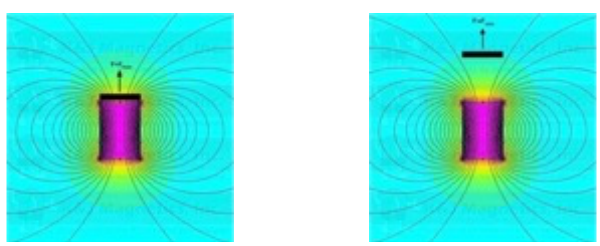

Figure-12, Projectile w/o warp bubble influence
$F_0 = 4.90$ newtons, $F_1 = 0.69$ newtons

The forces experienced by the warp projectile and the non-warp or pole-to-pole projectiles are presented in Figure-11 and Figure-12 and again displayed in Table-3 with maximum altitude and projectile mass for comparison. These results demonstrate the warp projectile experienced less than 25 percent of the average repulsive force experienced by the pole-to-pole projectiles but consistently reached greater altitude than the non-warp or pole-to-pole projectiles. These tests demonstrate the warp projectile outperformed the non-warp or pole-to-pole projectiles proving warp projectile **inertial mass** has been greatly reduced.

Table-3, Experimental Projectile Results

Projectile	Z_{max}	M	F_0 (d = 0)	F_1(d=D)	F_{avg}
Warp Projectile	**12.63 in 32.07 cm**	0.475 gm	0.0 newton	1.28 newton	**0.64 newton**
Non-Warp Projectile-1a	**7.2 in 18.29 cm**	0.615 gm	4.9 newton	0.69 newton	**2.80 newton**
Non-Warp Projectile-1b	**7.5 in 19.05 cm**	0.690 gm	4.9 newton	0.69 newton	**2.80 newton**

Summary of Results

It is postulated that magnetic fields may be combined to produce a warp bubble like the **expansion-compression** warp bubble predicted by Alcubierre's solution derived from Einstein's theory of general relativity but without the requirement for **negative energy**. These results are based on the theory that magnetic field forces of attraction and repulsion are a relativistic effect caused by fast moving electrically charged particles that distort space-time. As noted in Figure-5a and Figure-5b, field lines of magnetic energy diverge causing an **expansion** of space-time behind mass, **m**. At the same time, space-time in front of mass, **m** is **compressed**, an effect that shorten distances and compresses space-time. The **expansion** of space-time and the simultaneous **compression** of space-time in regions around intense magnetic fields described here are similar in principle to Alcubierre's warp drive. It is postulated that objects whose **inertia** has been reduced by a magnetic field warp bubble can accelerate to speeds and altitudes greater than similar objects of equivalent mass. An experimental device based on the magnetic field warp bubble successfully accelerated a projectile to altitude and speed greater than objects of equivalent mass when accelerated by magnetic-pole to magnetic-pole field orientation. It is hypothesized the greater maximum altitude for the magnetic field warp projectile compared to the **pole-to-pole projectiles** is due to the reduction of **inertial mass** while under the influence of the **warp bubble**. Conservation of energy would indicate altitude attained should follow the **inverse square law** for all projectiles tested because the magnetic field intensity at launch is nearly identical. Therefore, decreasing the inertial mass of a vehicle allows greater speed and maneuverability using conventional methods of propulsion like a rocket motor.

Figure-13, Energy field surrounding UFO in flight, **v < c**

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