Relativistic Kinetic Projectiles

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In this work, it is shown a method to build a type of kinetic projectile, which can reach relativistic velocities (≲300,000 km/h), with specific kinetic energy of ~10 Megatons/kg. This type of projectile can be very useful in a defense system that launches kinetic projectiles from Earth orbit to asteroids, meteoroids or comets in collision route with Earth.

Key words: Quantum Gravity, Gravitational Mass, Kinetic Projectiles, Earth's Defense System.

1. Introduction

A projectile which does not contain an explosive charge or any other kind of charge (bacteriological, chemical, nuclear, etc.) is called of *kinetic projectile*. When a kinetic projectile collides with the target its kinetic energy is converted into shock waves and heat [1]. Obviously, these projectiles must have an extremely high velocity in order to provide enough kinetic energy.

Typical Kinetic Projectiles

Projectile	Speed (Km/h)	Specific kinetic energy (J/kg)
25×1400 mm (APFSDS, tank penetrator)	6,120	1,400,000
2 kg tungsten Slug (Experimental Railgun)	10,800	4,500,000
ICBM reentry vehicle	Up to 14,000	Up to 8,000,000
Projectile of a light gas gun	Up to 25,000	Up to 24,000,000
Satellite in low earth orbit	~29,000	~32,000,000
Exoatmospheric Kill Vehicle	~36,000	~50,000,000
Projectile (e.g., space debris) and target both in low earth orbit	~58,000	~**130,000,000**

Here, we show a method to build a type of kinetic projectile, which can reach relativistic velocities (≲300,000 km/h), with specific kinetic energy of $\sim 10^{16}\,J/kg$ ($\sim 10\ \ Megatons/kg$). It was developed starting from a process *patented* in July, 31 2008 (BR Patent Number: PI0805046-5) [2].

2. Theory

The new expression for the *total energy* of a particle with gravitational mass M_g and velocity v, obtained in the *Quantization Theory of Gravity* [3], is given by

$$E_g = M_g c^2 = \frac{m_g c^2}{\sqrt{1-\frac{V^2}{c^2}}} = \frac{\chi\ m_{i0} c^2}{\sqrt{1-\frac{V^2}{c^2}}} \tag{1}$$

where $\chi = m_g / m_{i0}$ is the correlation factor between gravitational and inertial masses of the particle. In some previous papers [4] it was shown that the gravitational mass of a particle can be reduced by several ways (mechanical, electromagnetic, etc.). In the case of an electromagnetic field E_{rms}, with frequency f, applied upon a particle with electrical conductivity σ and mass density ρ, the expression for χ is given by

$$\chi = \frac{m_g}{m_{i0}} = \left\{1 - 2\left[\sqrt{1 + \frac{n_r^2 n^6 S_\alpha^2 S_m^4 \phi_m^4 \sigma\ E_{rms}^4}{16\pi\mu_0 \rho^2 c^4 f^3}} - 1\right]\right\} \tag{2}$$

where n_r is the index of refraction of the particle; S_α is the cross-section area of the particle (in the direction of the electromagnetic field); ϕ_m is the "diameter" of the atoms of the particle; $S_m = \frac{1}{4}\pi\phi_m^2$ is the cross section area of one atom; n is the number of atoms per unit of volume, given by

$$n = \frac{N_0 \rho}{A} \tag{3}$$

where $N_0 = 6.02 \times 10^{26}\, atoms/kmole$ is the

Avogadro's number; ρ (in *kg/m*^{3}) and A is the molar mass(*kg/kmole*).

Starting from Eq. (1), we can obtain the expression of the *gravitational kinetic energy* of the particle, i.e.,

$$K_g = \left(M_g - m_g\right)c^2 = \left(\frac{\chi\ m_{i0}}{\sqrt{1-\frac{V^2}{c^2}}} - \chi\ m_{i0}\right)c^2 =$$

$$= \chi\left(\frac{1}{\sqrt{1-\frac{V^2}{c^2}}} - 1\right)m_{i0}c^2 = \chi\ K_i \qquad (4)$$

where K_i is the *inertial kinetic energy* of the particle.

Thus, if a particle has initial velocity v_0, and we make $\chi \neq 1$, its velocity becomes equal to v, given by the following expression

$$\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right)m_{i0}c^2 = \chi\left(\frac{1}{\sqrt{1-\frac{v_0^2}{c^2}}} - 1\right)m_{i0}c^2 \qquad (5)$$

In the case of $v_0 << c$, we obtain

$$\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right) = \chi\ \frac{v_0^2}{2c^2} \qquad (6)$$

whence we get

$$v \cong c\sqrt{1 - \frac{1}{\left(1+\chi v_0^2/c^2\right)^2}} \qquad (7)$$

In a previous paper [5] it was shown that, if the *weight* of a particle in a side of a lamina is $P = m_g g$ then the weight of the same particle, in the other side of the lamina is $P' = \chi m_g g$, where $\chi = m_g / m_{i0}$ (m_g and m_{i0} are respectively, the gravitational mass and the inertial mass of the lamina). Only when $\chi = 1$, the weight is equal in both sides of the lamina. The lamina works as a Gravitational Shielding. This is the *Gravitational Shielding* effect. Since $P' = \chi P = \left(\chi m_g\right)g = m_g\left(\chi g\right)$, we can consider that $m'_g = \chi m_g$ or that $g' = \chi g$.

If we take two parallel gravitational shieldings, with χ_1 and χ_2 respectively, then the gravitational masses become: $m_{g1} = \chi_1 m_g$, $m_{g2} = \chi_2 m_{g1} = \chi_1\chi_2 m_g$, and the gravity will be given by $g_1 = \chi_1 g$, $g_2 = \chi_2 g_1 = \chi_1\chi_2 g$.

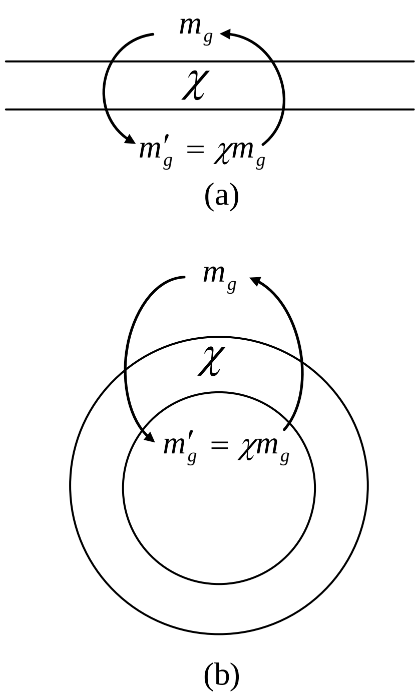

Fig. 1 – *Plane* and *Spherical* Gravitational Shieldings. When the radius of the gravitational shielding (b) is very small, any particle inside the spherical crust will have its gravitational mass given by $m'_g = \chi\, m_g$, where m_g is its gravitational mass out of the crust.

In the case of multiples gravitational shieldings, with $\chi_1, \chi_2, ..., \chi_n$, we can write that, after the n^{th} gravitational shielding the gravitational mass, m_{gn}, and the gravity, g_n, will be given by

$$m_{gn} = \chi_1\chi_2\chi_3 ... \chi_n m_g\ , \quad g_n = \chi_1\chi_2\chi_3 ... \chi_n g \qquad (8)$$

This means that, n superposed gravitational shieldings with different $\chi_1, \chi_2, \chi_3, \ldots, \chi_n$ are equivalent to a single gravitational shielding with $\chi = \chi_1\chi_2\chi_3 ... \chi_n$.

Now, consider a spherical kinetic projectile with n spherical gravitational shielding around it

(Fig.2). If the initial velocity of the system is v_0 then, when the n gravitational shieldings are actived, the velocity of the system, according to Eq. (7), is given by

$$v \cong c\sqrt{1-\frac{1}{\left(1+\chi_1\chi_2...\chi_n v_0^2/c^2\right)^2}} \qquad (9)$$

Note that by increasing the value of $\chi_1\chi_2..\chi_n$ the velocity v tends to c. Based on this fact, we can design the projectile *to travel at relativistic speeds*. For example, if $\chi_1 = \chi_2 = ... = \chi_n = -100$; $n = 6$ and $v_0 = 200m/s = 720km/h$, then Eq. (9) gives

$$v \cong c\sqrt{1-\frac{1}{\left(1+10^{12}v_0^2/c^2\right)^2}} \cong 0.7c \qquad (10)$$

Obviously, the kinetic projectile cannot support the enormous acceleration $\left(a \approx 10^{10} ms^{-2}\right)$ for a long time. However, if the time between the activation of the gravitational shieldings and the impact (time interval of flight with relativistic speed) is very less than 1 second, the projectile will not be auto-destructed before to reach the target.

Now, starting from equations (5) and (10), we can calculate the gravitational kinetic energy of the Relativistic Kinetic Projectile, i.e.,

$$K_g = \left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right)m_{i0}c^2 \cong 0.4 m_{i0}c^2 \qquad (11)$$

where m_{i0} is the rest inertial mass of the projectile. For example, if $m_{i0} = 1kg$, then $K_g = 3.6\times 10^{16}\ joules$. This energy is equivalent to $8.6\ \ megatons$.

The increase of energy $K_g - K_i$ comes from the Universe's gravitational energy [6], which connects, by means of the gravitational interaction, all the particles of the Universe.

$$K_g = \chi_1\chi_2...\chi_n K_i$$

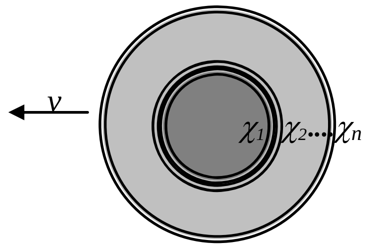

Fig. 2 – Relativistic Kinetic Projectile

2. Conclusion

The kinetic projectile here described can be very useful in a defense system that launches kinetic projectiles from Earth orbit to asteroids, meteoroids or comets in collision route with Earth. Depending on the orbits and positions in the orbits, the system would have an action wide range.

The system also would be used to defend the Earth in the case of an alien attack (In the last decades the radio transmissions strongly increased in the Earth, and can have call attention of aliens some light years far from Earth).

A relativistic kinetic projectile would be very hard to defend against. It has a very high closing velocity and a small radar cross-section. Launch is difficult to detect. Any infra-red launch signature occurs in orbit, at no fixed position. The infra-red launch signature also has a small magnitude compared to a ballistic missile launch.

Note that this kinetic projectile can also be launched from the Earth's ground to the target in the outerspace. The heating due to friction with the atmosphere is irrelevant because the time interval of the atmospheric flight, with relativistic speed, is very less than 1 second, and also because the projectile has a small cross-section. Thus, during the atmospheric flight, the temperature increasing does not cause damage on the non-tungsten components of the projectile.

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