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Gravitational Propulsion by Help of Vacuum Holes

Constantin Leshan

Department of Nuclear Physics, T. Shevchenko National University of Kyiv, Octeabriscoe, Moldova

Email address:
hole@i.ua

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Abstract: A new concept, the gravitational propulsion, or "Hole Levitation", is proposed which propels vehicle by using the artificial gravity (vacuum holes). Such gravitational propulsion is similar to gravitational slingshot but without the need for large masses like planets and complicate maneuvers. The source of artificial gravitation accelerates the vehicle in one direction and the surrounding medium in the opposite direction. Therefore, it is not a reactionless drive: momentum is taken from the surrounding stars and planets and conferred on the vehicle and thus is conserved overall. The artificial gravity generator can damp or neutralize inertial forces due to the levitating vehicle is able to move with large acceleration, which is not acceptable for other means of transport.

Keywords: Artificial Gravity, Vacuum Holes, Gravity Control, Levitation, Inertia

1. Introduction

Gravitational field propulsion is the concept of vehicle propulsion where no propellant is necessary but instead momentum of the vehicle is changed by an interaction of the vehicle with external force fields, such as gravitational fields from stars, planets, clouds of dust and gas [1].

Think about any method that allows propelling objects: you will find soon that gravity is the best thruster because it allows large acceleration without forces of inertia. The hole technology allows manned vehicle to move with large acceleration that is inaccessible for all modern transport. Usually, a manned vehicle will require more time to reach its top speed as humans have limited tolerance to acceleration. In this context, all manned propulsion systems have fundamental limits for the rate of acceleration – at large acceleration the forces of inertia can kill the crew and destroy the delicate and fragile parts of the vehicle. On the contrary, the pilots of proposed levitating device do not feel any forces of inertia even at acceleration of thousands of "g" because they free fall into the gravitational well. Thanks to hole vacuum technology, the future flying devices will have the best maneuverability.

The proposed propulsion concept is similar to gravity assist, which have been in use for interplanetary spacecraft missions for decades. For example, Voyager spacecraft obtained a speed 17 km/s after a gravity assist maneuver near Jupiter and Saturn to increase the velocity.

Gravity assist maneuver can change the speed of a spacecraft without expending propellant, but this method has limits [2]. The main limit to the use of gravity assist maneuver is that large masses like planets and moons are seldom in the right place to enable trip to destination. Another limitation is the planet's atmosphere, which prevents the closer approach of the spacecraft to the planet. Because of these limitations, gravitational slingshot is used seldom.

We propose a new propulsion technology called "Hole Levitation" that is similar to gravity assist but avoids all listed above limitations. Namely, the vehicle does not need the massive planets for propulsion because it has its own source of artificial gravity; the vehicle free falls into the artificial gravitational well. The advantage of this solution is that the vehicle is free to change its rate of acceleration and direction of movement and does not depend on external planets.

It is clear that momentum obtained by the Voyager while passing a Jupiter is taken from the planet and conferred on the vehicle and thus is conserved overall. The current proposal uses the same principle – the vehicle free falls to the source of gravity. The only difference is that instead of Jupiter the vehicle uses its own source of artificial gravity (vacuum holes). Thrust (momentum) obtained by the vehicle while passing the artificial gravitational field is taken from the surrounding planets and stars, clouds of dust and gas, and conferred on the vehicle and thus is conserved overall.

This process of acceleration of objects by vacuum holes [3]

is called sometimes "Hole Levitation" [4] due to possible existence of the deep symmetry between classical and quantum methods of motion. The hypothesis we want to put forward strengthens the link between levitation and teleportation on one hand and classical methods of motion on the other. Namely, we know two classical methods of motion as uniform rectilinear motion and motion with acceleration. It can be shown that levitation repeats the properties of motion with acceleration and teleportation repeats the properties of uniform rectilinear motion [5]. Probably, levitation is a super-analogue of motion with acceleration whereas teleportation is a super-analogue of uniform-rectilinear motion. Perhaps, there are two fundamental methods of motion in nature only which looks differently at the microscopic and macroscopic scales.

This propulsion principle is not similar to Alcubierre's warp drive [6]; it is a technology based on the hole vacuum physics that doesn't use the exotic matter. In addition, it is not a superluminal technology; levitating vehicles move more slowly than light always.

The propulsion concept "Hole Levitation" can be used in a mobile or stationary version. In the first case, the onboard gravitational thruster accelerates the vehicle by emitting vacuum holes. The stationary version is a gravity catapult able to shoot manned vehicles into space. Since the vehicle does not feel the forces of inertia, therefore the acceleration rate in such a "gun" may exceed thousands or even millions of "g" without killing the crew.

2. Artificial Gravity and Gravity Control

The notion of “artificial gravity”, in this paper, refers to gravitation created by artificial vacuum holes. The hole generator is a device able to create the artificial holes in the space-time by help of various physical processes and phenomena (but not by help of gravitating mass). Of course, the gravity generator is also made of gravitating matter, but we consider only gravity generated by physical processes and phenomena. That is, mass alone is not the only source of gravity. In General Relativity the source of gravity is what is called the energy-momentum tensor, which includes both energy and momentum densities as well as stress. Therefore, it follows that GR allows creating the artificial gravity by using various processes and phenomena that converts one form of energy in another (but not by help of gravitating mass). The freedom from mass allows us to control gravity.

The only way modern science knows how to create a gravitational field is the same way nature does it – by accumulating a lot of matter in one place. The hole theory of gravitation proposes a new method of creating artificial gravity by producing the large holes in spacetime. That the source of vacuum holes produce gravitation was shown already in references [3, 7, 8]. The construction of the effective generators of vacuum holes is the next goal that will allow us to control gravity. The hole generator can be used for levitation and teleportation [5].

The imaginary line between a vacuum hole and the material Universe is called the "border of the Universe" because outside of the material Universe exist neither matter nor space-time; it is an absolute void or a vacuum hole. Since this absolute void does not contain material things, therefore it is not a part of the material Universe.

According to Hole Vacuum theory, the microscopic vacuum holes continually appear and disappear in space-time. In other words, the border of the Universe passes through every point in the space-time. In this context, we can create large holes by expanding small holes. To create a large hole we must spend energy in order to expand the borders of the Universe. Another way to produce a hole in space-time is that we must remove from a vessel all the body contained in it, without permitting another body to occupy its place [7, 9].

Since a vacuum hole exist a short time only, the hole generator emits short pulses of gravitation (probably gravitational waves).

A hole generator allows to control gravity because we can switch on and off gravity by starting and stopping the physical processes that create holes. In contrast, we are not capable to switch off and on the Earth's gravity because it is the natural gravitation generated by gravitating mass.

Another important property of the hole generator is that we can "move" the source of artificial gravity to other location in space almost instantaneously that allows controlling the flight. For this purpose, we simply stop the generation of holes in one place and start the same process in another place. For an external observer, it is equivalent to the disappearance of a large mass in one place and its reappearance in another. It is impossible to repeat this procedure with natural gravitation; we cannot replace almost instantaneously the large gravitating masses along the vehicle for the propulsion goals; for example, we cannot replace the large asteroid from one side of the vehicle to another. Due to these remarkable properties, the artificial gravity produced by the hole generator is able to propel vehicles.

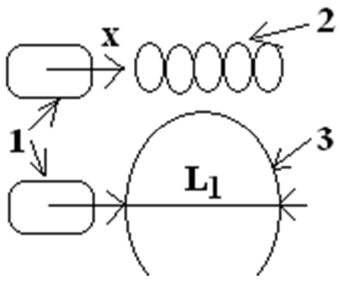

Figure 1. *There 1 is the vehicle, 2 – non-symmetrical gravitational field, 3 spherically symmetrical gravitational field.*

The gravitational field can be symmetrical or non-symmetrical, depending on the distribution of the vacuum holes in space. The non-symmetrical gravitational field is the most suitable for propulsion because we can increase the value of free fall acceleration g along the one preferred direction.

As show Fig. 1, the advantage of a non-symmetrical gravitational field is that a few holes distributed along a line with the length L_1, produces the same free fall acceleration g

along the x-axis as the large vacuum hole with the same diameter L_1. It means that an weak hole generator producing a non-symmetrical gravitational field have the same propulsion effect as an powerful hole generator producing spherically symmetrical gravitational field. It allow us to produce the large g-forces along the direction of motion (propulsion) by using the weak hole generators. The disadvantage of this method is that at large acceleration the gravitational forces tear the vehicle apart.

3. The Physics of Gravitational Levitation

3.1. Hole Levitation Is Falling into the Artificial Gravitational Well

Hole Levitation phenomenon can be understood in two different ways. In short, we can propel the vehicle: 1) by creating an artificial gravitational field (vacuum holes) near a vehicle; 2) by reproducing the inverse phenomenon of inertia. Both these statements are equivalent.

Let us begin with the simplest explanation. In order to propel a pointlike mass m_1 (vehicle) using gravitation, we bring another mass m_2 from an infinite distance away to a position 1 m from m_1. Then, according to the universal gravitation law, both masses m_1 and m_2 begin to move with acceleration to each other. In fact, both objects start from rest and fall toward each other. It is the gravitational propulsion since the vehicle m_1 moves with acceleration due to gravity. Of course, the "crew" feels no forces of inertia.

Unfortunately, the acceleration of the mass m_1 (vehicle) stops after collision with m_2. Even if we avoid collision using different techniques, the mass m_2 cannot be used again for propulsion due to the momentum conservation laws in an isolated system; it is impossible to accelerate the spaceship by manipulating with onboard masses. It is like trying to move a car by pushing on it from the inside.

Now imagine that m_1 is the space probe Voyager and m_2 is a planet like Jupiter. Since our goal is to accelerate m_1 using the gravitational field of m_2, we would use the gravity assist. A gravity assist changes a spacecraft's velocity (relative to the Sun) by entering and leaving the gravitational field of a planet. In other words, the space probe is exposed to Jupiter's gravitational sphere of influence for short time due to gravity can accelerate/decelerate the probe. The reason why gravity assist requires that all involved objects (the space probe and planets) must be in motion is just to introduce/remove the probe to planet's gravitational sphere of influence in the most efficient way – when a spacecraft flies past a much more massive body.

Thus, for gravitational propulsion (multiple acceleration of the mass m_1 by help of the gravitational fields), modern science proposes one method only – the gravity assist.

Let we introduce now the new technique for gravitational propulsion (gravity assist) based on vacuum hole technology, or artificial gravity. The basic idea in the gravitational assist is to introduce and remove the probe into the gravitational well in the most efficient way. Meanwhile, there is another way to introduce/remove the probe into/from the gravitational well without using massive planets and complicate trajectories.

Let us consider again the above experiment with two bodies at rest, m_1 and m_2. Our goal is to accelerate m_1 using the gravitational field of m_2. Imagine that we substitute the mass m_2 by the source of artificial gravity V_0 (the generator of vacuum holes). The generator produces the large holes in spacetime by help of explosions; suppose that the products of explosion do not affect the vehicle. Now we can "switch on" and "off" gravity many times, effectively introducing and removing the body m_1 into the gravitational well. It is the same gravitational slingshot but without the need in planets and complicate maneuvers. The source of artificial gravity m_2 can accelerate or decelerate the spacecraft, depending on its position (like gravity assist technique).

To increase the rate of acceleration, it is proposed to create the asymmetric gravitational field in front of the vehicle. Namely, if the number of vacuum holes would be created along the direction of motion, the value of free fall acceleration in this direction will exceed free fall acceleration in other directions.

In empty space, the behavior of the vehicle depends strongly on the position of the source of artificial gravity. There are two fundamentally different cases: 1) The source of artificial gravity lies within vehicle's centre of mass; 2) The source of artificial gravity is outside of the vehicle's centre of mass.

The present gravity machine may be controllable and maneuverable only in case if the source of artificial gravity is outside of its centre of mass. In this case, artificial gravitation attracts stronger the heavier part of the vehicle than the light one due to the vehicle as a whole moves with acceleration. The controlled gravitational propulsion disappears only when the source of artificial gravity lies within the vehicle's centre of mass. Now, the artificial gravity has nothing to propel due to the vehicle behaves as a usual massive body. Such uncontrolled vehicle will fall to the nearest source of gravity, but the benefit is appearance of the weight, or Earth-like gravitation. The weightlessness in space softens astronaut's bones and causes their muscles to weaken. However, the crew can use both methods in succession depending on what they need – acceleration or weight (gravity). In other words, the weight (gravity) appears only in case when the gravitation attracts the astronauts but cannot propel the vehicle with the same rate.

3.2. Hole Levitation Is the Inverse Process to Inertia

There are virtual holes in every point of space. All massive material particles interact with vacuum holes continuously and emit their own holes. Since a particle interacts with the holes continuously, at acceleration well expand also vacuum holes that interact with this particle at the same moment of time. Thus, material bodies resist acceleration by expanding myriads of vacuum holes.

The proposal is to run this process in reverse for propulsion goals. For example, a particle moving with acceleration 10

m/s^2 creates behind them holes with the diameter D_h. If we create the same holes D_h near another identical particle then one will move with the same acceleration 10 m/s^2 and without forces of inertia; Forces of inertia do not arise when a material object is accelerated by gravitation (gravitation is another name for vacuum holes [8]).

The flying device will be "inertialess" only if we will reproduce exactly the (inverse) process of inertia as it occurs in nature. As mentioned above, when a body moves with acceleration, it "expands" microscopic vacuum holes by its every component particle. Therefore, the forces of inertia attract uniformly all parts of the given body. However, it is technologically impossible to reproduce exactly the phenomenon of inertia because we are not capable to create the myriads of vacuum holes inside of a solid body; what is more, we must place these artificial holes ahead of every component particle.

Instead, in order to simplify the technology of levitation, we create a thin layer of holes in front of the vehicle. This solution is technologically realizable and allows "inertialess" propulsion but causes some problems. Namely, the rate of acceleration cannot be arbitrary large due to appearance of tidal gravitational forces. Since gravitation is inverse squared, therefore the head parts of the vehicle will gain more acceleration than its back parts. Thus, at large acceleration (using large holes) the tidal gravitational forces tear the vehicle apart into pieces.

Two solutions may prevent the destruction of the vehicle by the gravitational forces: 1) the vehicle must have the most suitable form. For example, the spherical form allows more uniform distribution of gravitational forces along the vehicle than the shape of the plane or rocket. 2) There is a proposal to create the artificial holes inside of the vehicle (in the critical points) in order to reduce tension (stretching) caused by tidal gravitational forces.

The source of vacuum holes can be used as an inertia damper (compensator) to counter or damp the effects of inertia or other forces. It is not neutralization of inertia as physical phenomenon, but rather compensation, or neutralization of effects of inertia (or forces of inertia). Even if the vehicle executes complicate maneuvers with large acceleration, the crew remains in weightlessness conditions because the artificial gravity generator counteracts the forces of inertia.

The suggested inertia damper works in following way: Suppose that the external force accelerates the vehicle due to it resist acceleration by producing vacuum holes behind of every component particle. Now if we produce the same holes on the opposite side of the every component particle, the effects of inertia must disappear. Even if the external forces accelerate/decelerate the vehicle, the fast hole generator controlled by an computer can reduce G loads to a minimum.

It is the only compensation or neutralization of effects of inertia by help of vacuum holes but not the negation or loss of inertia as described in science fiction. In fact, inertia as the physical phenomenon can't be shut off. The onboard observer can prove easily that all levitating objects have the property of inertia always.

3.3. Conservation of Energy and Momentum

Actually, the levitating vehicle propels by help of its own source of artificial gravity. This explanation might seem to violate the conservation of energy and momentum, but the effects on the environment have not been considered. If no mass is being ejected from the vehicle, where is the thrust coming from?

In spite of the fact that propulsion using manipulation with onboard masses is forbidden by conservation laws, the propulsion using artificial gravity is possible due to the following reasons:

1. The gravitational wave argument. If the vehicle is equipped with pulse generator of non-symmetric artificial gravitational field, it cannot be considered as an isolated system already because it interacts with the external gravitational fields. The pulses of non-symmetrical artificial gravity "steal" momentum from the surrounding objects (elementary particles, dust and gas, far planets and stars) located along the trajectory. The linear momentum gained by the vehicle is equal in magnitude to that lost by the surrounding clouds of dust and gas, planets and stars.

The hole generator is a pulse generator that emits very short pulses (waves) of the non-symmetrical gravitational field, which is able to carry momentum. It is generally known that gravitational waves are able to carry energy, momentum, and angular momentum over large distances. For this reason, if a hole generator emits gravitational waves, it cannot be considered as an isolated system already.

2. The unique properties of vacuum holes argument. When two equal masses m_1 and m_2 interact gravitationally, momentum is imparted to these bodies. Namely, after gravitational interaction the first body m_1 gains momentum $p = m_1v_1$ and the body m_2 gains the opposite momentum $-p = m_2v_2$. Now if we substitute the mass m_2 by the vacuum hole V_0, then an important distinction arises: the body m_2 is able to carry momentum because it possesses such important properties as long lifetime, mass m and velocity v. But the stationary vacuum hole V_0 (not to be confused with moving holes) disappears quickly because its lifetime is very short, approximately $T_h \geq 10^{-24}$ s. It is self-evident that a non-existing object is not able to carry momentum. Momentum p is the mass times velocity, $p = mv$, but if the object do not exist, then its mass $m = 0$ and therefore the notion of "velocity" v is senseless, hence the non-existing object is not capable to carry momentum. Since V_0 is not able to carry momentum, the momentum conservation law requires that the opposite momentum $-p = m_2v_2$ must be carried by gravitation (vacuum holes) to environment.

By the way, let us mention that the gravitational radiation (moving holes) is able to carry momentum because these holes have long lifetimes, since they propagate in space like holes in electric current [8]. Holes are capable to carry momentum because they are capable to accelerate objects [8]. Nevertheless, the source of artificial gravitation V_0 in the above example is a *stationary hole* that lives a short time only, emitting other, moving holes that are able to carry momentum.

3. Migration of the centre of mass argument. Let we have two equal masses m_1 (vehicle) and m_2 that are in touch (the closed, isolated system). Now the crew works against the gravitational force increasing the distance between these objects from $r = r_0$ to $r = r_1$. Then both objects free fall to each other due to gravity. After that, we repeat this procedure again. It is clear that such manipulations with onboard masses cannot change the vehicle's net momentum due to conservation laws.

Now let us substitute the mass m_2 by the hole V_0 (artificial mass) that periodically appears and disappears in the same position in respect to the vehicle. Therefore, it only attracts the vehicle m_1, without the need to work against gravity in order to increase the distance between m_1 and V_0, as described above. In other words, since the mass V_0 disappears, there is no need to work against gravity in order to increase the distance between m_1 and V_0. Consequently, it causes the appearance of a force that propels the vehicle m_1 in one direction and the surrounding medium in the opposite direction. We repeat again this cycle where V_0 only attracts m_1 without the need to work against gravity in order to increase the distance between m_1 and V_0.

Let the hole V_0 is produced outside of the vehicle, and the mass of the vehicle m_1 is equal to V_0, $m_1 = V_0$. When the source of artificial gravity V_0 is active, then the center of mass of the system $(m_1 + V_0)$ is at the halfway point between m_1 and V_0. When the artificial mass V_0 disappears, then the system's $(m_1 + V_0)$ centre of mass coincides with vehicle's centre of mass. Since the artificial mass V_0 periodically appears and disappears, consequently the vehicle's centre of mass migrates continually. Since objects will tend to move to the center of gravity, it means that the artificial gravity generates a force that propels the vehicle in one direction and the surrounding medium in the opposite direction.

4. Step-by-Step Explanation

Let's describe the process of gravitational propulsion in detail. Imagine that the vehicle m_1 is placed at distance 2R, $R = 6.37 * 10^6$ m from a test body m_3, as show Fig. 2.

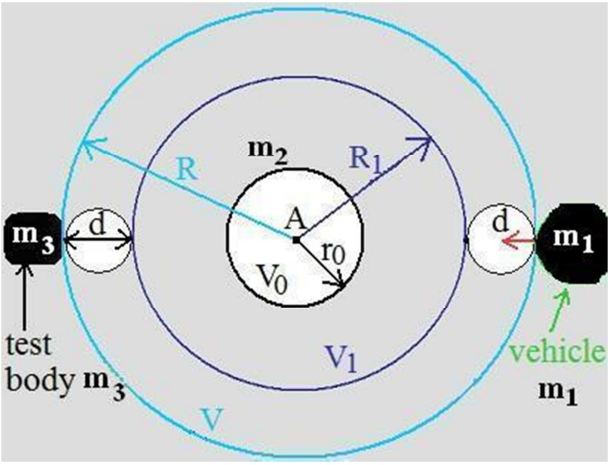

Figure 2. *Both objects m_1 and m_3 start from rest and fall toward each other; The source of holes in point A generates the volume of holes V_0 during a second.*

Such "astronomical" distances and masses were chosen in order to show clearly that hole levitation does not violate the momentum conservation law.

The vehicle m_1 is going to fly to the test body m_3 using gravitational propulsion only. For this purpose, we must create an artificial gravitational field V_0 in front of the vehicle. To make a more clear picture, we'll use a very powerful hole generator which creates the same number of holes as Earth, because we are familiar with free fall acceleration $g = 9.8$ m/s^2.

The hole generator, which is located in the middle of distance in the point A, works in a pulsed mode; it creates every second a stream of holes with summary volume $V_0 = 5.012*10^{15}$ m^3 and radius $r_0 = 1.062*10^5$ m.

At the moment of time t_0, a hole V_0 begins to collapse and to the moment t_1 the volume V_0 will be equal to zero. Therefore, the sphere V decreases in size: $V - V_0 = V_1$ due to the holes with diameter d = 9.8 m appears near the vehicle and test body m_3 (see Fig. 2):

$$d = R - R_1 = R - \sqrt[3]{R^3 - r_0^3} = 9.8 \text{ m} \qquad (1)$$

Thus, the hole generator that creates a number of holes with total volume V_0 every second causes the appearance of hole radiation that curves the surrounding space-time and accelerates objects. In other words, the source of holes V_0 manifests itself via creation of holes "d" that accelerate surrounding small objects m_1 and m_3, whose mass (gravitation) can be ignored. In this context, we can study the motion of small objects m_1 and m_3 by taking into account the influence of the holes "d" only. The hole "d" is a sum of all microscopic holes that accelerate objects during a unit of time (a second in this case).

At the moment of time t_0, a hole "d" begins to collapse and to the moment t_1 the volume of "d" will be equal to zero. Therefore all surrounding objects will move with acceleration to the center of holes "d"; for example, the vehicle m_1 passes the distance 4.9 m up to the centre of hole "d". Since the source of holes m_2 also passes the distance 4.9 m up to the centre of hole "d", therefore the speed of the vehicle m_1 with respect to m_2 will be V = 9.8 m/s. In the next moment of time t_2 the cycle repeats and therefore the vehicle m_1 passes the distance 9.8 m by inertia, and besides, is again accelerated by a hole "d", moving to the center of hole "d" the distance 4.9 m. Thus the vehicle m_1 has passed the distance $S = 4.9 + 9.8 + 4.9 = 19.6$ m during first two seconds. Continuing this experiment we shall find, that the body moves by the law $S = gt^2/2$, which describes the free falling in a gravitational field.

The vehicle m_1 starting from rest will attain a speed of 9.8 m/s with respect to m_2 after one second, 19.6 m/s after two seconds, and so on, because m_2 also moves with acceleration to the center of hole "d". Since the test body m_3 moves in the opposite direction, the speed of the vehicle m_1 in respect to m_3 will be V = 19.6 m/s after fist second and V = 39.2 m/s after two seconds. The free-fall acceleration "g" concerning the center of summary hole with radius r is:

$$g = kr^3/3R^2, \; k = 1/s^2 \qquad (2)$$

The conclusion of this imaginary experiment is that if the

vehicle begins to move using gravitational propulsion (Hole Levitation), the opposite bodies and particles gain the opposite momentum. If we substitute the body m_3 by far stars or planets in this experiment, they will also gain momentum. It is a proof that the law of conservation of momentum holds in Hole Levitation. The energy conservation law also holds because we spend energy to produce the vacuum holes, which accelerate the vehicle and the surrounding medium.

If the source of artificial gravity V_0 is placed closer to the vehicle, the efficiency of gravitational propulsion increases due to gravity's inverse square law. The closer is the source of gravity to the vehicle, the larger is acceleration. I can prove that the vehicle propels even if the source of artificial gravity is placed inside of this vehicle. In this case, the artificial gravitation attracts the heavier part of the vehicle in one direction and the surrounding medium in the opposite direction due to the vehicle's net momentum changes. One may disagree, partially or wholly, on this point: an electromagnet cannot propel the vehicle, if it is placed inside of this vehicle. The answer is that the nature of gravitation differs from the electromagnetism. Unlike electromagnetism, the gravitational radiation (waves) interacts with *all* external objects and fields, due to the vehicle's net momentum changes. Besides, we create the non-symmetrical gravitational field by distributing holes along the direction of motion.

5. Gravitational Catapult

Jules Verne described in 1865 a giant gun that launched three men to Moon. Afterwards were proposed a lot of similar devices for non-rocket space launch like railguns, coilguns, mass drivers and other catapults. The first publication of the concept may be Newton's cannonball in his 1728 book [10]. The essence of these concepts is to use a single impulse to directly send a payload into space. Although all these systems promise to throw objects up into space for a very low price, human launches are not possible due to limited tolerance of humans to acceleration. To remove these limits, we propose the gravitational catapult that is able to throw manned vehicles into space without killing the crew.

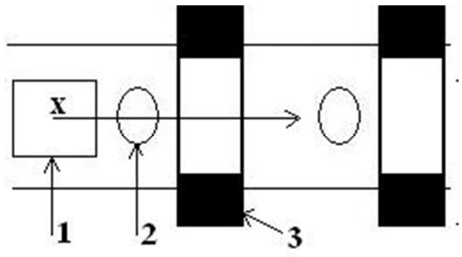

Figure 3. *A section of the gravitational catapult; there 1 is a vehicle, 2 - the vacuum hole (artificial gravity), 3 - the massive rings.*

In fact, a gravitational catapult is a deep gravitational well which consists of a light tube, massive rings and the hole generators. The hole generators create the non-symmetrical gravitational field by producing many vacuum holes along the x-axis, thereby increasing the value of free fall acceleration *g* along the x-axis. Therefore, a vehicle 1 free falls into the gravitational well, along the x-axis. The main gravitational force is created by synchronized sequential switching of individual hole generators. When the vehicle approaches to the massive ring, the hole generators produce the large hole 2 which accelerate the vehicle forward and the ring in opposite direction. It provides a clear demonstration that the law of conservation of momentum holds for hole levitation.

Strong centering gravitational force "levitates" vehicle for minimal wall contact. The gravitational catapult may act as machine gun also, launching vehicles one by one after short intervals of time.

Another possibility is to combine the inertia dampers based on vacuum hole technology with other space launch systems. For example, we can combine the inertia dampers with slingatrons, railguns, coilguns, space guns (cannonballs), and so on, in order to reduce G loads to a minimum. The gravitational catapult may be installed also on the Moon, Mars or in space, in order to eliminate the atmospheric drag losses.

6. Conclusion

The gravity-based propulsion technology could revolutionize space travel and enable interstellar voyages. A vehicle equipped with artificial gravity generator is able to surpass the fundamental limits of their predecessors; it is the propulsion without forces of inertia, which requires no propellant mass.

The paper showed that we could propel vehicles by using artificial gravitation (vacuum holes) and without violating conservation laws. There are real examples of similar gravitational propulsion as gravitational slingshot and free falling; the difference is only that instead of gravitating matter we use artificial gravitation (vacuum holes). There are other examples of Hole Levitation in quantum physics where vacuum holes accelerate particles.

The next step is to research interaction between vacuum holes and matter in order to create the effective sources of artificial gravity (hole generators). Unfortunately, I can research the physics of vacuum holes theoretically only because I have neither laboratory nor support. I hope that other scientists interested in this question invite me.

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