Floating Off

The possibility of overcoming the limitations of our Earthbound existence has fascinated Mankind since the dawn of History. It has engaged the imaginations of Religious groups, Philosophers, Authors, Artists, and dreamers of every description. Cultures abound with stories of Magic Carpets and Winged Gods.

Practical people have also attempted to address the problem, and have achieved a certain amount of success. As one observer remaked wryly… "*If you put a big enough engine in it, anything will fly.*"

The energy required to overcome the force of Gravity still promotes interest in the possibility of some form of "*Antigravity*" which would afford anyone the freedom to "*Float off*" on the slightest whim.

Levitation is not to be confused with Weightlessness. A desire for weightlessness is much more than searching for an ability to be raised clear of the ground. It requires that the very fabric of the individual be absolved from the burden of those forces which create fatigue. From my childhood, I recall many instances as I was on the point of sleep. I became unaware of my body and felt I was able to float above my bed. I imagined I could look down on myself sleeping. Perhaps it is this kind of semi-conscious childhood fantasy which drives people in their search for antigravity.

Whatever the motivation, consideration of the behaviour of Gravity seems to be a prerequisite in the search for any means of neutralising its influence.

The first essential characteristic of Gravitational attraction is that it is what is known as a "*Central*" force. This means that Gravity acts as though the matter which constitutes a body is entirely located at the centre of mass of that body. The centre of mass of a spherically symmetric object is at the centre of the sphere. In the case of an irregularly shaped body, the position of the centre of mass can be determined experimentally. In some cases it may be calculated from the shapes which constitute the overall mass.

The second characteristic is that the Gravitational Field acts purely on Mass, which is the amount of "*Substance*". In other words, it depends on the number of atoms which comprise the body under consideration and their individual masses. No other property of the Mass is of any consequence whatsoever to the Gravitational effect. From the point of view of Gravity, a 1Kg piece of steel behaves in exactly the same way as 1Kg of wood, or a 1Kg slice of Sirloin Steak.

Unlike Electromagnetic Fields, there is no known means of screening the Gravitational Field.

Furthermore, Gravitation does not exhibit polarity, and there is no known effect which suggests that Gravitational repulsion might exist. There is also no known limit to the range of Gravitational influence.

One point which is not emphasised in the textbooks is that Gravity acts independently and simultaneously on every single atom and molecule throughout a body. Similarly every single atom and molecule exerts a Gravitational attraction on every other atom and molecule in the body, and indeed throughout the Universe.

There is an old examination question which assumes the existence of a tunnel through the diameter of the Earth from one Pole to the other. A stone is dropped in at one end of the tunnel. What happens?

By making all sorts of simplifications for the purpose of the exercise, it turns out that the stone executes simple harmonic motion, oscillating forever back and forth through the centre of the Earth. The stone just reaches the surface at each pole before returning back through the tunnel to the opposite side of the globe. In essence the Earth's Gravitational field diminishes as one descends from the surface, becoming zero at the centre of the Earth.

In addressing the question of weightlessness in the vicinity of Earth, the velocities involved are small enough for relativistic considerations to be ignored.

However it is important to be aware of the existence of these considerations. In general terms, whenever events occur at speeds approaching the speed of light, corrections need to be introduced due to relativistic effects. Perhaps the most well known equation arising from Relativity Theory is Einstein's Mass - Energy equivalence relationship.

$$E = M \times c^2$$

In this relationship, "*E*" is the equivalent energy of a given mass "*M*" and "*c*" represents the speed of light. Note that the mass concerned is not moving at the speed of light. The speed of light is merely the constant which relates mass and energy. Mass-energy equivalence confirms that every mass can be considered as an energy and every energy can be regarded as a mass. Consequently every physical thing in existence is merely an energy, and vice versa.

Under non-relativistic conditions, the simple relationship defining the Gravitational force acting between two objects is

$$F = G\left\{\frac{(M_E \times M)}{r^2}\right\} \quad \text{——— 1}$$

When "M_E" is taken to be the mass of the Earth, the force "*F*" is the Gravitational attraction which the Earth exerts on the body "*M*". Equally, the body M exerts exactly the same force on the Earth as a whole. The Gravitational Constant is denoted by "*G"* and the separation of the centres of mass of the two Masses is denoted by "*r*".

The Gravitational relationship stated above has been confirmed to hold, at least out to distances approaching the limit of the Solar system. Interestingly, that analysis was carried out using discarded data from the Pioneer missions. Some of the tapes on which the data was stored were discovered in boxes under a stairwell.

Another property of Mass is known as "*Inertia*". Inertia is quite distinct from Weight although Mass will in general demonstrate both properties. Inertia opposes any change in the velocity at which a Mass is travelling. In other words, Inertia resists acceleration. A force must be applied in order to produce acceleration in any Mass.

Gravity is generally taken to define the direction which is to be regarded as vertical. Forces which act at ninety degrees to one another are said to be "*Orthogonal*". The effects of forces which are orthogonal to one another can be analysed independently. Thus, forces can be applied to a Mass in the Horizontal plane, allowing the effect of the force on a Mass to be investigated independently of the effect of Gravity. Experiments of this nature permitted Isaac Newton to conclude that the behaviour relationship between mass and an applied force through the centre of mass was a linear one defined by the equation.

$$F = M \times a \quad \text{———} \quad 2$$

In the above equation, "*F*" represents the applied force, and the acceleration produced by that force on the mass "*M"* is represented by "*a*".

If the applied force is arranged to be directed through the centre of mass, acceleration will occur in a straight line. Under these conditions, the applied force appears to behave in a manner similar to the Force of Gravity acting on a point mass.

If the force does not act through the centre of mass, then rotation will also occur in the Mass.

The behaviour of a Mass when a force is applied in a direction other than through the centre of mass is used to advantage in the majority of ball games in order to spin the ball in a particular direction.

Notice that an object orbiting a second object is not in itself a rotation in the orbiting body. An orbiting body may possess some rotation through other causes such as collisions or electromagnetic influences, which in turn may have been the result of Gravitational effects.

It does not matter how many different bodies interact through Gravity, the individual contributions always combine into a single resultant force on each body.

Linear Inertia in a Mass is more usually referred to simply as Mass.

Rotational Inertia is a further property of the quantity of "*Substance*" in a body. It is quite distinct from Linear Inertia, because it is determined by the manner in which the substance is distributed throughout the body.

Furthermore, if the substance of a body is not spherically symmetric and homogeneous, it will have more than one value of Rotational Inertia. These values are termed "*Moments of Inertia*". A Bowling Ball represents one example of an object which appears to be spherically symmetric but is not homogeneous. A spherically symmetrical homogeneous object has a single value for its Moment of Inertia irrespective of which axis through its centre is chosen for rotation. However, an ellipsoidal shape like a Rugby Ball will have one value for its Moment of Inertia about its long axis, and a second value of Moment of Inertia about ANY axis which passes through the centre of the ball in the plane at ninety degrees to the long axis.

Rotation of a Mass defines an axis, and thereby a direction in three dimensional space. This property is used in the Gyroscope. A rotating Mass can be moved along any straight line in space and the direction of its spin axis will be unchanged. The Mass can also be accelerated along any straight line in space, and the direction of its spin axis will remain unchanged.

Note that the position of the axis and linear velocity in space are being changed in these cases. Only the direction of the spin axis remains unaltered.

On the other hand, any attempt to change the direction of the axis of spin will give rise to what is known as Precession. It has already been noted that the spin of the object defines one axis in space. An equivalent expression is to state that the rotating Mass defines a plane in space at 90 degrees to its spin axis. In turn, any plane is defined by two directions, also at 90 degrees to one another. When the axis of the spinning mass is deflected, the axis simultaneously rotates from its original direction into a new direction which lies in a plane at 90 degrees to the direction in which the deflecting agency was applied.

Assume the three axes in space are labelled x, y, and z. Then if the body has an axis of spin lying in the x axis,

and an attempt is made to rotate it about the y axis, the body will simultaneously rotate about the z axis.

Mathematically, the interaction of the rotating Mass and the intended rotation of its axis is defined by a "*Vector cross product*". This type of behaviour is also observed in Electromagnetism.

The gyroscope does not respond to rotational accelerations about its own axis of rotation. Nor does it respond to linear acceleration of that axis. The gyroscope only responds to rotational acceleration which changes the orientation of its spin axis.

There is a very important distinction between Mass and "*Weight*". Weight is what is shown by devices such as the spring balance. The reading on that type of instrument is determined by the force applied to a spring. The "*Spring*" may take different forms, and may appear to be a virtually rigid bar, but ultimately some amount of deflection takes place.

The Weight of an object is taken to be the force which the spring balance exerts in holding the mass stationary against the pull of the Earth. Mass is a property of the body, but Weight is dependent on circumstances. For several reasons, the reading shown for a single given Mass will vary according to the location on Earth and also according to measurement conditions.

In contrast, a counterpoise balance compares one mass against another. Once in balance, it will remain so throughout the Universe.

Equations 1 and 2 each provide a relationship between Force and Mass. Thus the two equations can be combined by substituting for Force in Equation 1.

$$M \times a = G\left\{\frac{(M_E \times M)}{r^2}\right\} \quad \text{---} \quad 3$$

In equation 3, the mass of any object under consideration appears on both sides of the equation showing that the relationship is independent of the Mass itself. Thus equation 3 reduces to.

$$a = G\left\{\frac{M_E}{r^2}\right\} \quad \text{---------} \quad 4$$

Equation 4 shows that the effect of Earth's Gravity is to produce an acceleration in any Mass. It also shows that the acceleration only depends on the distance "r", of the mass from the centre of the Earth. The amount of "*Substance*" is irrelevant. The same acceleration occurs in a small Mass as in a large Mass at the same distance from Earth.

It was earlier noted that the Weight of a Mass is the force that is required to support the Mass against the Gravitational attraction.

Achieving weightlessness is not difficult. All that is required is to remove the cause of support and permit the Gravitational attraction to have its full accelerational effect on the Mass.

When any item is dropped from a height, it experiences weightlessness initially. As its speed increases, air resistance comes into effect and applies a force which offsets the force of gravity. The Weight of the object increases until a velocity may be reached at which the resistance of the air due to the speed of the fall exactly balances the accelerating force due to Gravity.

At that point it may be argued that levitation has been achieved. It is, however, usual to regard Levitation as being associated with zero vertical velocity. Thus a Ping-Pong ball balanced on a jet of air would generally be regarded as being levitated, whereas a skydiver would be said to have reached terminal velocity. From a Physics point of view, the two conditions might well be regarded as equivalent.

In the School laboratory, momentary weightlessness is demonstrated in the feather and coin experiment. A feather and coin are placed in a long Glass tube. The tube is inverted, and it can be seen that the coin falls to the lower end of the tube much faster than the feather.

The tube is then connected to a vacuum pump and the Air removed from the tube. Air resistance having been eliminated, both the feather and the coin drop to the lower end of the tube in the same time interval whenever the tube is inverted.

Like levitation, weightlessness is commonplace. On the other hand, whereas levitation can be sustained virtually indefinitely under appropriate conditions, sustaining weightlessness based on the current level of Scientific understanding, presents an insurmountable challenge on Earth.

Notice that the concept of weightlessness is a condition in which the force of Gravity is permitted to act without restriction on the environment under consideration. This is the same as saying that the complete environment is permitted to accelerate under the Gravitational force, whatever value that force may have.

It is important to appreciate the distinction between velocity and acceleration.

A projectile fired directly upwards starts with a high velocity. Due to that velocity, it must initially overcome a very large amount of air resistance. Throughout its travel the projectile experiences the force of Gravity

accelerating it towards the Earth. Initially, the Air resistance is also acting downwards, in the same direction as the force of Gravity. If it was possible to make a measurement of the projectile's weight during this part of its trajectory it would appear to be acting in an upward direction. In other words, the projectile would register a negative weight.

From an analysis standpoint it is more convenient to consider the Kinetic Energy possessed by the projectile by virtue of its upward velocity. This Energy is partly consumed by the air resistance and is partly converted into Potential Energy which the projectile possesses by virtue of its height above the Earth.

As the vertical speed of the projectile decreases, the projectile experiences a progressive reduction in this negative weight, being momentarily weightless at its apogee. At this point, the projectile has no upward velocity and is still being accelerated downwards by Gravity.

Notice that the actual acceleration due to Gravity at the apogee will be less than it is on Earth since the distance of the projectile from the centre of the Earth has increased slightly. This can be seen by referring to Equation 4.

As the projectile falls back to Earth, its velocity increases. Air resistance rises once more. This time the air resistance acts upwards opposing the force of Gravity. If it was possible to make a measurement of the projectile's weight under these conditions, it would be found to be positive and equal to the force created by the air resistance.

It is only when the projectile is held stationary against the force of Gravity that the weight reading will correspond with the familiar concept of Weight.

In the case of a spacecraft, air resistance drops to zero long before the upward velocity of the spacecraft has dropped to zero. Although the spacecraft may continue travelling away from Earth, it is still being accelerated towards Earth. As with the projectile, the accelerating force diminishes as the spacecraft travels further from Earth.

In order to consider the options available to the experimenter attempting to achieve sustained weightlessness, it is essential to examine the equation which determines Weight, or in other words the force of Gravitational attraction.

The Gravitational Constant "*G*" is to my mind the most fundamental of all Physical Constants. The experimenter cannot do anything to change it. The masses under consideration, being the amount of "*Substance*" cannot be altered without changing the items themselves.

Obviously if an astronaut goes on a slimming diet he or she can reduce Mass and thereby approach weightlessness to a degree, but the astronaut also approaches masslessness in direct proportion. Similarly, the Mass of the Earth cannot be altered.

Placing anything at the centre of the Earth is impractical. Even if an item could be placed at the centre of the Earth, weightlessness would only be approached insofar as the Mass of the Earth is concerned.

Under static conditions, the only available option is to increase the separation of the bodies.

Bearing in mind that the present period of Human History is not one of outstanding creative or innovative thought, perhaps the best guide to what is possible is to consider the attempts which were developed by those who were responsible for training astronauts 60 years ago.

As far as I am aware, the longest periods of "*Weightlessness*" achieved in the West, occur within an aircraft during a power dive. The aircraft accelerates towards Earth at a rate which matches the acceleration due to Gravity at the corresponding altitude.

The equation of interest is:

$$V = U + a\,x\,t \qquad \text{——— 5}$$

Here the final velocity is "*V*". The initial velocity is denoted by "*U*". The speed increases by an amount determined by the product of the acceleration "*a*" and the time "*t*" for which the acceleration operates. If the acceleration has a negative value, the final velocity will be lower than the initial velocity. Note that Equation 5 only applies directly for constant acceleration.

Whether acceleration is ascribed a positive or negative value, and whether it may be regarded as constant, is decided upon by the circumstances of the problem.

Taking the acceleration due to Gravity = 10m/s^2, the velocity, after 33 seconds, assuming a stationary start, will be 330m/s, which is nominally Mach 1. Even on the point of stall, the initial velocity of an aircraft is unlikely to be anything less than 60m/s. A large aircraft of the type used for training astronauts would begin to feel somewhat uncomfortable in the region of Mach 1. The pilot would probably start to pull out of the dive at around Mach 0.7 or about 230m/s. It would take 17 seconds for an object falling freely under Gravity to increase its speed from 60m/s to 230m/s. This places an upper limit on the duration of weightlessness.

Taking into account the commencement period, during which the aircraft enters the dive and accelerates, my understanding is that the weightlessness condition can only be sustained for about 8 - 12 seconds. As a technical solution, it seems characteristically American. The approach is inconvenient, expensive, risky, and very glamourous.

For their part, the Soviet Union adopted the much more sensible and economic principle, possibly first employed by Galileo at the leaning Tower of Piza, and used extensively in industry when low gravity effects are desired. The Soviet cosmonauts were simply dropped down the lift shaft of Moscow State University. Whether or not the lift shaft in Moscow was evacuated for the Soviet trials, I do not know.

For longer periods of training, immersion in water is used. This permits neutral buoyancy, but that is not the same as weightlessness, and incurs the penalty of a pressure acting on the body. It is a form of Levitation. If the training involves the manipulation of equipment, then that equipment must be configured to have neutral buoyancy. For example if the immersed trainee picks up a stone which weighs about 1Kg in air, it will feel as though it weighs about 0.5Kg. On the other hand, a piece of steel which weighs 1Kg in air will feel as though it weighs about 0.9Kg when picked up under water. When either item is released, it will fall to the bottom of the tank. In addition, all movements must be made against the viscosity and density of the water. The movements will be affected by turbulence in the water.

The general concept of Weight is perfectly satisfactory for the overwhelming majority of human endeavour. There are nevertheless instances when the concept is insufficiently defined. One problem which arises from equating Weight to the static force of Gravitational attraction is that no account is taken of accelerated motion which may take place under the influence of the gravitational attraction.

One important form of accelerated motion occurs when one body orbits a second body in a stable orbit. This is the condition of a satellite orbiting the Earth. In these circumstances, the force of Gravity attracting the bodies to one another is exactly balanced by the accelerated motion of the orbit.

In space travel, weightlessness is only approximate, and the more suitable term "*Microgravity*" is used. Astronauts orbiting Earth experience a fluctuating Gravitational field in exactly the same way as we do here on Earth. However, because they are further away from the large mass of the Earth, the value of the acceleration due to Gravity from that source is much lower.

The reader will notice that the terms "*Force*" and "*Acceleration*" have been used more of less interchangeably. The two are distinct, but the relationship between the two is Force = Mass x Acceleration. Within the context of a single Mass, Acceleration is often an appropriate surrogate for Force.

Experiments have been carried out using volunteers who spent long periods of time lying in a horizontal position. From the point of view of blood flow, this limits the pressure differentials across the body. Furthermore, compression of the bones is minimised. Nevertheless the volunteer will still sense the presence of the force of Gravity through whichever part of his or her body is providing support. Such experiments are not entirely satisfactory since correct bodily function requires physical exertion.

Another point for consideration is the issue of whether or not it is possible to distinguish between a mechanically applied acceleration and a Gravitational acceleration.

Many hold the view that from the point of view of the observer, denied any external reference datum, no such differentiation is possible. This apparent difficulty of distinguishing between applied force and the Gravitational attraction makes the possibility of devising some antigravity device all the more tantalising.

To illustrate this commonly held view regarding differentiation, it is a simple matter to swing a bucket of water around in a circle in a vertical plane. The speed of the swing can be adjusted so that when the bucket is directly overhead, the water is technically weightless. It will remain in the bucket because the radial acceleration due to rotation exactly matches the downward acceleration due to Gravity. However, the condition is only momentary, and at the bottom of the swing, the water will instantaneously weigh exactly twice what it does under stationary conditions. Clearly from the point of view of the external observer there are two different processes. However from an observer in the bucket itself, denied any external reference, the cause of the fluctuating weight which the observer experiences cannot be attributed to distinct causes, and could equally result from a single influence.

A person standing on the Earth is not unlike the water in the bucket. The rotation of the earth creates an acceleration on the person which detracts from the Gravitational acceleration. To a first approximation at least, this effect will be smallest at the Poles and maximum at the Equator. Thus a person should weigh more at the Poles than they do at the Equator.

Similarly, someone travelling in a direction opposite to that of the Earth's rotation is actually heavier than they are when stationary in relation to the Earth. This in-

crease will reach a limit when their rotational speed matches the rotational speed of the earth. At that speed the traveller will have negated their initial rotational speed which they possess by virtue of their position on Earth, and will effectively have no rotational speed. At that speed their weight will have the same value it would have at the Poles. If their rotational speed is increased further, their weight will start to decrease once more.

A person travelling in the same direction as the rotation of the Earth experiences a reduction in weight, because their rotational speed adds to whatever rotational speed they had by virtue of their location on Earth. The faster the person travels the greater the effect.

Additionally, in the case of Air travel, irrespective of the direction of travel, passengers experience a slight reduction of weight which results from the altitude of the aircraft having increased the separation between the passengers and the Earth.

Orbiting satellites simply utilise a combination of increased separation distance and increased rotational speed.

Although, the Earth rotates about its own axis, the centre of mass of the system, which to a first approximation comprises the Earth and the Moon, is displaced from the Earth's axis of rotation. The most obvious manifestation of this offset is the presence of two tides every day instead of the one which would be expected if the system's centre of mass was coincident with the Earth's axis of rotation.

The changing relationship between the Sun, Moon, and Earth alters the tidal extremes throughout the Lunar cycle. The planets all have their influence, as does every other celestial body.

The ceaseless motion of the tides serves as a perpetual reminder of our own fluctuating Weight. We also experience a variation due to the four week Lunar Cycle, and throughout the Earth's annual orbit of the Sun.

If one examines a plot of the gravitational field between the Earth and the Moon, it will be noticed that there is a point at which the attractions of the two bodies cancel. Any spacecraft which travels between the Earth and the Moon decelerates steadily albeit under the diminishing effect of the Earth's Gravitational attraction. Meanwhile it experiences a steadily increasing attraction from the Moon. At the point where the two attractions are balanced, the spacecraft reaches its lowest velocity. Thereafter the craft begins to accelerate as the influence of the Moon's Gravitational attraction begins to dominate.

A Mass which orbits the Earth in synchronism with the Moon at the distance where the Gravitational fields are balanced, will experience an extremely small gravitational field. However, the conditions necessary for a stable orbit do not exist where Gravitational fields are in balance.

Earlier it was pointed out that levitation appears to be weightlessness, but they are distinct phenomena. Levitation is widespread in daily life.

The force of Gravity is purely Physical and its behaviour is well understood.

Ever since the earliest Indian Rope trick, magicians have entertained audiences by achieving the "*Impossible*". Modern technology has permitted the art of deception to reach a very high order of realism.

Furthermore, members of the General Public have become conditioned through Film, Television, and Virtual Reality presentations to accept illusion as reality to an unprecedented extent.

A Flight Simulator can present an illusion which will convince the majority of those who experience it. However, any person who has practical experience of moderate or high energy flight immediately recognises that the "*G*" forces which ought to accompany the visual prompts are absent, and the illusion fails.

Any assessment of apparent weightlessness must be examined with the utmost care.

There is nevertheless the matter of Paranormal, or Metaphysical effects, which have been reported to give rise to Levitation. These accounts cannot be discarded lightly and have traditionally been attributed to Supernatural Influence. Levitation, psychokinesis, and telepathy have been observed and documented by reputable individuals. Often the events occur in association with high levels of emotional or Physical stress in some individual other than the observer.

None of the instances of which I am aware were predictable, repeatable, or sustained. Some observed effects may be caused by an ability within the human body to create strong electromagnetic fields for brief periods.

Simply considering the single issue of fluctuating weight, described in an earlier paragraph, it should come as no surprise that sensitive individuals experience cyclic changes in mood. The moods may follow the Lunar Cycle, a propensity which gave rise to the term "*Lunatic.*" Our decisions are often influenced by our moods. Amongst other things, this applies to Investment decisions. It is well known that the Stock-

markets of the World exhibit periodic fluctuations corresponding to the Lunar Cycle.

The phenomenon of spontaneous combustion is another example which some might regard as an instance of paranormal activity. However, Methane can ignite spontaneously. This is well known as the Will-o-the-wisp. Dampness in haystacks promotes rot, releasing Methane, which can ignite of its own accord, sometimes destroying the crop and barn.

I am aware of one account of a sailing ship, destroyed as a consequence of the spontaneous combustion of bales of Jute which had become damp prior to loading. These instances do not relate to weightlessness, but illustrate the manner in which ordinary events can acquire a reputation for having mystical origins.

The overwhelming majority of people on Earth align themselves with one Religious group or another. Nevertheless, there is undoubtedly a strong Modernist preference to regard unexplained phenomena as being created by "*Extra-terrestrial*" beings.

Despite their limitations and ultimate unprovability, my preferred view is that when Physical explanations are inadequate, Supernatural interpretations present explanations which are more nearly rational and credible than those offered by models based on some form of extra-terrestrial life.

It is perhaps a reflection of an innate Human frailty that the concept of some all powerful and possibly benevolent "*Creator*" or "*Life Force*", is preferable to the prospect of some undefined "*Alien*" life form which influences our existence according to its own unspecified "*Interests.*"

My preference may arise from the fact that the concept of "*Supernatural*" represents a much higher level of existence and power than that of any "*Extra-Terrestrial*" beings.

These latter require some form of transport for their conveyance and life support. They are ultimately limited in their range of influence.

If one feels obliged to attribute events to some higher power, there is no sound basis for limiting the extent of that power.

This is "*X-File*" territory, and FBI Agent "*Mulder*" is unlikely to share my opinions. I stop abruptly short of the catch phrase "*I want to believe*".

We would at least agree that "*The truth is out there*". Nevertheless, wanting to believe is possibly the greatest obstacle to gaining knowledge of the truth.

The most impressive aspect of Human Knowledge is Human Ignorance. This reality is the underlying motivation for Scientific research. However, a desire to gain new knowledge does not confer on anybody or any organisation the ability to do so, irrespective of the magnitude of the resources available.

In recent years, a large number of reputable Scientists wanted to believe that their experimental results proved that Neutrinos travelled faster than the speed of light. Their motivation for wanting to believe was very strong, and took the form a possible Nobel Prize for Physics, with its attendant glittering career prospects. Their desire to believe overcame their capacity for objectivity and rational scientific analysis.

In comparison to such "*Scientists*", my standpoint may be regarded as somewhat mundane.

"*I am prepared to consider the evidence*".

There might yet be a discovery which permits sustained weightlessness on Earth. In light of the effort which has been expended on the search to date, the probability of discovering an antigravity mechanism is vanishingly small. The value of visual evidence is always suspect and strictly limited. Any claim of weightlessness must be accompanied by a specification of the Physical mechanisms involved. It must be possible to demonstrate and replicate those mechanisms independently and without doubt. Furthermore the mechanisms must withstand the scrutiny of Mathematical Analysis.

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