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Activation of Autophagy Process in Cancerous Cells at *Quasi-Zero Gravity* Environments

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Autophagy is a well-known process of cell death. In this work we show that it can be activated in cancerous cells at *Quasi-Zero Gravity* environments. The result is the total destruction of the cancerous cells without use of medicaments.

Key words: Cancerous Cell, Autophagy, Microgravity, Quantum Controllers of Gravity.

The gravitational acceleration experienced by an object in a *microgravity* environment, by definition, is one-millionth (10^{-6}) of that experienced at Earth's surface (g_{\oplus}). Consequently, a *microgravity* environment is one where the acceleration induced by gravity has very little effect ($g \approx 1\mu g_{\oplus}$).

Only three methods of creating a microgravity environment are currently known: to travel far enough into deep space so as to reduce the effect of gravity by *attenuation*, by *falling*, and by *orbiting* a planet.

The first method is the simplest in conception, but requires traveling an enormous distance, rendering it most impractical with the conventional spacecrafts. The second method, *falling*, is very common but approaches microgravity only when the fall is in a vacuum, as air resistance will provide some resistance to free fall acceleration. Also it is difficult to fall for long enough periods of time. There are also problems which involve avoiding too sudden of a stop at the end. The NASA Lewis Research Center has several drop facilities. One provides a 132 meter drop into a hole in the ground similar to a mine shaft. This drop creates a reduced gravity environment for 5.2 seconds. The longest drop time currently available (about 10 seconds) is at a 490 meter deep vertical mine shaft in Japan that has been converted to a drop facility.

Drop towers are used for experiments

that only needs a *short duration of microgravity*, or for an initial validation for experiments that will be carried out in longer duration of microgravity.

Aircraft can fly in parabolic arcs to achieve period of microgravity of 20 to 25 seconds with g-level of approximately 0.02 g. The airplane climbs rapidly until its nose is about 45-degree angle to the horizon then the engines are cut back. The airplane slows; the plane remains in free fall over the top of the parabola, then it nose-dives to complete the parabola, creating microgravity conditions.

Aircraft parabolic flights give the opportunity to perform medical experiments on human subjects in real microgravity environment. They also offer the possibility of direct intervention by investigators on board the aircraft during and between parabolas. In the mid-1980s, NASA KC-135, a modified Boeing 707, provided access to microgravity environment. A parabolic flight provided 15 to 20 seconds of 0.01 g or less, followed by a 2-g pull out. On a typical flight, up to 40 parabolic trajectories can be performed. The KC-135 can accommodate up to 21 passengers performing 12 different experiments. In 1993, the Falcon-20 performed its first parabolic flight with microgravity experiment on board. This jet can carry two experimenters and perform up to 3 experiments. Each flight can make up to 4 parabolic trajectories, with each parabola lasting 75 seconds, with 15 to 20 seconds of microgravity at 0.01g or less.

The third method of creating a microgravity environment is *orbiting* a planet. This is the environment commonly experienced in the space shuttle, International Space Station, Mir (no longer in orbit), etc. While this scenario is the most suitable for scientific experimentation and commercial exploitation, it is still quite expensive to operate in, mostly due to launch costs.

A space shuttle provides an ideal laboratory environment to conduct microgravity research. A large panoply of experiments can be carried out in microgravity conditions for up to *17 days*, and scientists can make adjustment to avoid experiment failure and potential loss of data. Unmanned capsules, platforms or satellites, such as the European retrievable carrier Eureka, DLR's retrievable carrier SPAS, or the Russian Photon capsules, the US Space Shuttle (in connection with the European Spacelab laboratory or the US Spacelab module), provide *weeks* or *months* of microgravity.

A space station, maintaining a low earth orbit for several decades, greatly improves access to microgravity environment for up to *several months*.

Thus, microgravity environment can be obtained via different means, providing different duration of microgravity. While *short-duration microgravity environments* can be achieved on Earth with relative easiness, *longer-duration microgravity environments* are too expensive to be obtained.

In a previous paper we shown that the intensity of the local gravity can be controlled by means of a device called Quantum Controller of Gravity (QCG) [1]. Fundamentally, a QCG can have any spherical form (ellipsoidal, spherical, spherical cylindrical, etc.). Figure 1 shows a system with 1 (one) spherical QCG (shell with thickness Δx).

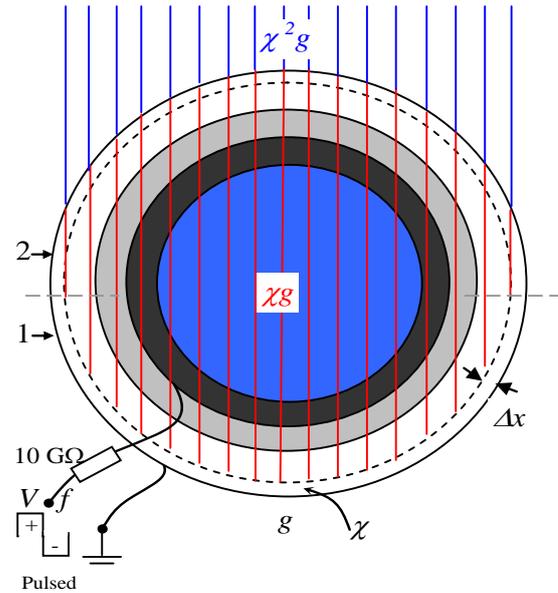


Fig.1 – The shell with thickness Δx works as a *Quantum Controller of Gravity*.

As show in the figure above, the gravity in the blue spherical region becomes χg , where χ is the expression of the correlation between gravitational mass and the rest inertial mass of the QCG, which is given by [1]

$$\chi = \frac{m_g}{m_{i0}} = \left\{ -2 \left[\sqrt{1 + 2.64 \times 10^{-3} V} - 1 \right] \right\} \quad (1)$$

where V is the voltage applied (See Fig.1).

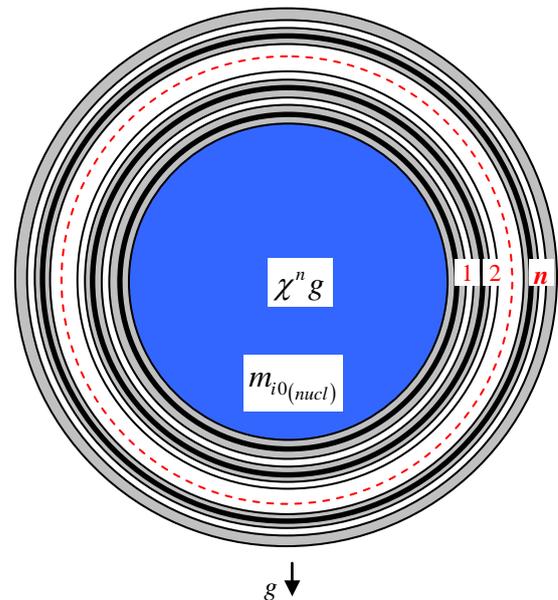


Fig. 2 – A system with n QCG

It is possible to build a system with n concentric QCGs (See schematic diagram in Fig. 2.). In this case, the gravity inside the system becomes $\chi^n g$ [2].

Here, we propose to use QCGs, in order to create, a *Quasi-Zero Gravity*¹ environments of longer-duration, at Earth's surface. Due to the cost of the QCGs to be relatively low, also the *Quasi-Zero Gravity* environments of longer-duration. will be produced with low costs.

This possibility is absolutely new and unprecedented in the literature.

The *Quasi-Zero Gravity* environments produced by QCGs will be a special tool for ultra-low gravity research. It will allow to improve and to optimize physical, chemical and biological processes on Earth that are important in science, engineering and also medicine.

In this work we show that the well-known *Autophagy* process (cell death) can be activated in cancerous cells at *Quasi-Zero Gravity* environments of longer-duration.

Consider a non-relativistic system with mass m and velocity v in a gravitational field. Its kinetic energy is $K = \frac{1}{2}mv^2$ and its potential energy in the gravitational field is $U = -GMm/r$; M is the mass of the body (spherical with radius r) that creates the gravitational field. Under these circumstances, the total energy of the system, E , is given by

$$E = K + U = \frac{1}{2}mv^2 - GMm/r \quad (2)$$

Note that the potential energy *reduces* the *total* energy of the system. Consequently, if it is *decreased* then the total energy of the system will be *increased*.

The Eq. (2) can be rewritten in the following form:

$$E = \frac{1}{2}m[v^2 - (2GM/r^2)r] = \frac{1}{2}m[v^2 - 2|g|r] \quad (3)$$

¹ $g \ll 1\mu g_{\oplus}$. Here we use the term *Quasi-Zero Gravity* because the term *zero-gravity* is, obviously inappropriate since the *quantization of gravity* [2] shows that the gravity can have only discrete values *different of zero*.

where g is the gravity acceleration produced by the mass M .

Note that, if *gravity g is reduced* the energy E *increases*. This explains why the *cellular metabolism increases* in microgravity environments. That is, if a cell is placed in a microgravity environment, then, according to Eq. (3), its total energy increases and, consequently, its metabolism will be *accelerated*. Therefore, *strongly* reducing the gravity that acts on a cell it is possible *strongly* increase its cellular metabolism. The healthy cells are able to support this effect for a long-time. But the cancerous cells do not support by a long time the *metabolic stress* [3,4,5] produced by the strong acceleration of their metabolisms and, at a given moment, they activate the *Autophagy* process which leads to death of the cancerous cells.

This fact is not new, several papers [6, 7, 8, 9] show that the cells are strongly affected by microgravity and under certain conditions can activate the *Autophagy* or *Apoptosis* process. The novelty is the possibility the use of QCGs in order to create, at the Earth surface, *Quasi-Zero Gravity* environments of longer-duration which can activate the *Autophagy* or *Apoptosis* process.

Now consider that the body with the mentioned cancerous cells is on Earth's surface. Considering Eq. (3), in this case, we can take $r = r_{\oplus} = 6.378 \times 10^6 m$ and $\bar{v} \propto 1\mu m.s^{-1}$ (\bar{v} is the average speed inside the cells; the length scale of human cells is about $\sim 1\mu m$).

In order to make $2gr_{\oplus} \ll \bar{v}^2$ in Eq. (3), we must reduce the value of g down to $g \ll \bar{v}^2/2r_{\oplus} \propto 10^{-20} m.s^{-2}$. An environment with this level of gravity can be considered a *Quasi-Zero Gravity* environment. Since $g = \chi^n g_{\oplus}$ then, we must make

$$\chi^n \ll 10^{-21} \quad (4)$$

If we make $n = 30$, we must have $\chi < 0.2$ in order to satisfy Eq.(3). It is important to note that the value of χ cannot be in the interval: $-0.159 < \chi < +0.159$ because this is

the condition to transform a particle into an *imaginary* particle [2].

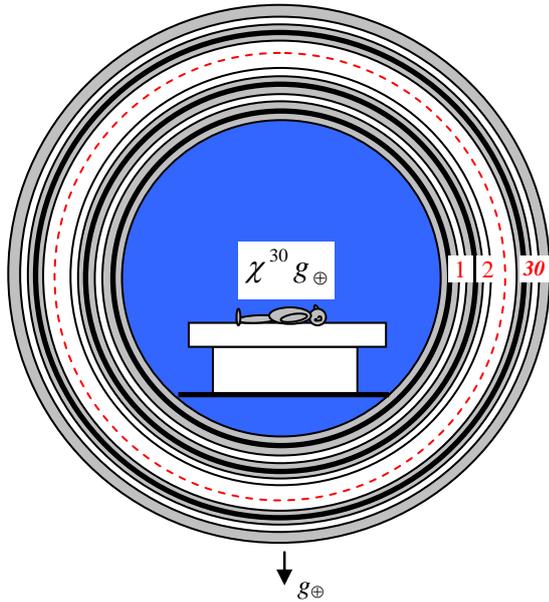


Fig. 3 – A *Quasi-Zero* Gravity Chamber on Earth's surface with 30 QCGs

Figure 3 shows a *Quasi-Zero Gravity Chamber*, where $n = 30$ and $\chi < 0.2$. The *Quasi-Zero Gravity* environment produced by the chamber ($g \ll 1 \times 10^{-21} g_{\oplus}$) will activate, after a time interval, the Autophagy process in all cancerous cells of the body inside the chamber. The result is the cure of the cancer.

The *time intervals*, inside the *Quasi-Zero Gravity Chamber*, which each type of cancerous cell (or set of them) requires in order to be destroyed only can be determined by means of experimental studies.

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