A Theory of Gravitational Generation to Mitigate Space-Induced Low Gravity – Relevance to Premature Aging in Space

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Abstract

Artificial gravity is among the key goals for successful long-term space exploration. Over the last century, several possible theoretical models have been proposed. As far as we are aware, use of centrifugal rotation is the only major form of artificial gravity that has been significantly tested. There are disadvantages to this system including the high degree of speed needed to produce a force to recapitulate earth's gravitational field. We tested the potential efficacy of diamagnetic levitation as a form of artificial gravity. This study capitalized on its unique capacity to uphold desired aesthetic attributes while adjusting gravitational forces per specific conditional requirements. The model emphasized on methods by which diamagnetic levitation negate the detrimental consequences of prolonged weightlessness on human physiology, leading to premature age. By offering a detailed exploration of the potential of diamagnetic levitation and its implications, this research

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contributes to a deeper understanding of the critical role of the potential for artificial gravity on long-term visit to space. The findings and insights presented herein serve as a valuable resource for future space missions and the development of space habitation technologies, guiding interdisciplinary scientists towards the realization of safer, healthier, and more sustainable human ventures beyond earth's confines. We discussed the positive impact on premature aging for long-term habitation in space.

Keywords: Aging, diamagnetic levitation, artificial gravity, osteoporosis.

Introduction

Artificial gravity is undergoing intense research due to its importance in physiology, particularly for space travel of humans. The complex processes in low gravity have untoward effects on human physiology [1]. To experimentally study the physiological effects of gravity in vertebrates, and to dissect how these effects can be mitigated, one must create artificial gravity within a spacecraft. Specifically, to generate a relatively homogenous field of force that affects the entire vertebrate, perhaps with consistency in all tissues. To counteract the physiological effects of low gravity, it would be necessary to create a force of gravity like earth. In this regard, artificial gravity holds paramount importance in space exploration, particularly to mitigate the adverse effects of microgravity on human organ systems.

A major benefit of artificial gravity is that humans could spend prolonged time in space. There is anticipation of other critical problems such as the time needed to accommodate sub-light travel speed and the fragility of systems that must withstand the vacuum of space. These issues must be addressed for the success of long voyages. Taken together, these problems complicate the process of stable space transportation. To solve the overall issues discussed in this section, it is important to address even minor advancements.

The scientific community has gained much information on the effects of low gravity on human physiology. This was based on medical observation on human astronauts who spent time in space. The literature reported on the loss of vision and decreased bone and muscle mass [2]. Other noted effects include the loss of stamina and power [3]. Missions to mars and beyond if require more than 300 days of accommodation in microgravity, would likely cause physiological and biochemical changes [1]. Additional health issues reported for the returned astronauts include challenges when readjusting to earth's environment, perhaps due to delayed acclimatization to microgravity.

Artificial gravity can negate the untoward physiology caused by a lack of gravity in space while easing the readjustment to challenges when humans return to terrestrial life [4]. Such adjustments would be relevant for extended lives of organisms that have inhabited the International Space Station (ISS). Upon returning to Earth after an extended stay in microgravity, astronauts face challenges with balance and coordination. The reintroduction of gravity can make simple tasks such as standing and walking difficult, requiring rehabilitation, and retraining to restore normal locomotor function.

An interesting report pertains to the effects of microgravity on the circadian rhythm [5]. Currently, children are not sent to space but rather, individuals who are beyond mid-age, >40–45 yrs. At this age, there could be malignant cells without clinical cancer [6]. Since circadian rhythm is linked to cancer, the effects of space on circadian require studies [7]. The reports also link dysfunction in the immune response of astronauts with delayed healing of wound and fracture [8]. Microgravity has a negative impact on genomic stability, which is supported in the twin studies conducted by NASA [9]. The same study indicated increased telomeres in the twin who spent time in space. Change in circadian rhythm, combined with increased telomere, and decreased immune functions point to microgravity-induced premature aging.

One of the primary challenges faced by astronauts is muscle atrophy with the report indicating muscle loss by 20% every 5–11 days in space [10]. Another concern is the redistribution of body fluids. In the absence of gravity, fluids tend to accumulate in the upper body, leading to facial puffiness and vision impairment. This is also known as fluid shifts that could lead to cardiovascular and other physiological issues. Additionally, the lack of downward pressure in microgravity can cause the brain to have a sensation of floating within the skull. Studies show that space travelers can lose bone mineral destiny at about 1% per month from the lumbar spine and more from the hip.

Currently, spaceflights require the most athletic individuals, due their ability to accommodate better to microgravity, as well as reintroduction to gravity [11]. Part of the fitness regimen includes daily exercise for about 2 h [12]. This regimen would restrict space travel for aged or infirmed. We propose that the introduction of artificial gravity would open space to all ages.

Diamagnetic levitation is a technique that manipulates magnetic fields to induce the levitation of objects. Specifically, it can apply force to substances traditionally seen as non-magnetic such as biological tissues. Thus, theoretically, proper design and application of diamagnetic levitation could benefit artificial gravity. In an effective system, diamagnetic levitation serves the purpose of confining organisms to the spacecraft's floor thereby preventing objects and living beings from floating. Such a method would be ideal if applied to a force on earth's force of gravity. If so, this will create what is referred to as artificial gravity to counteract the untoward effects of low gravity on human tissues and organs. A gravitational field could be accomplished by creating an electromagnet oriented as a solenoid or platformed surface in the living quarters of a spacecraft. There are several methods by which diamagnetic levitation in space can be achieved. Examples include one in which the object and organism would reside inside the coils, and another where a powerful magnetism generating platform could exert force from above or below.

Although electromagnets and magnetic levitation are used on earth, as far as we are aware, very little is used in space for gravitation or structure. Instead of using a large rotation device such as a centrifuge which requires power and speed, magnetic levitation requires power. Earlier, experiments on earth and space tested artificial gravity through centrifugal force.

The initial experiments attempted to create artificial gravity in space during the Gemini XI mission on September 14, 1966. This significant, yet straightforward experiment, involved employing a tether between the spacecraft and the Agena Target Vehicle, generating a centrifugal force that produced approximately 0.00015 *g* of gravity [13]. Thus, decades of studies proved that artificial gravity could be achieved in space through centrifugal force. Similarly, artificial gravity experimentation was reported by Skylab missions in the 1970s [14]. This featured a rotating wheel designed to simulate centrifugal force, spinning at 3 revolutions per minute, mimicking an artificial gravity to recapitulate earth's gravity. The crew inhabited the space station for extended durations, making this experiment influential for insights on the physiological effects of artificial gravity on the human body. The Skylab instruments recorded negative nitrogen balance, showing muscle loss [15]. The Skylab experiments proved that loss of muscle fibers could not be regenerated. Since then, scientific breakthroughs in regenerative medical suggests a potent for clinical intervention to regenerate muscle. In 1991, the Spacelab Life Sciences 113 mission aboard the Space Shuttles studied on the impact of microgravity on human physiology indicated positive effects of artificial gravity [16]. Although other experiments involving centrifugal models have been conducted, the available data remains limited due to the scarcity of research in this field. Here we report on simulated model to show that the one coil method to achieve gravity could be a model for future studies.

Methods

The following methods describe 2 methods to establish artificial gravity with magnetic levitation:

(i) Coils

Coils could be a potential method to achieve artificial gravity with magnetic levitation. This could be achieved using 10 coils or 1 coil (Figure 1). The magnetic field must exert a force equivalent to gravity, which is known as the *magnetic levitation force* as well as *maglev*. To simulate the force of gravity that is felt on earth, we used the following equation, refer to as the coil equation. This equation was derived from Ampere's Law.

$$F = (n * i)^2 * \mu * \frac{a}{(2 * g^2)}$$

F represents the amount of force generated by i (current) and n (number of turns); g = the length between the solenoid and the object; a = the area of the cross-section. Thus, F provides the electrical current, respective to the constraint of the space where the objects are located. The magnetic susceptibility of the human body $= -10 \times 10^{-6}$ and the permeability of free space $= 4\pi \times 10^{-7}\ T\ \frac{M}{A}$, which is commonly referred to as μ and μ_0.

(ii) Platform of permanent magnet

The second theoretical method to generate gravity is through one long and short permanent diamagnetic magnets. These materials, although not permanent magnets, could be altered with an electromagnetic coil. Once a current is added, the magnet loses its magnetic properties, resulting in a theoretical method of gravity that eliminates electricity.

Results

Since magnetic force is bi-directional, there is one possible arrangement to retain an organism/object inside the coil. This would require eukaryotes and other organisms, and objects to live in the free area between the coils (Figure 1). The proposed equation would develop a model to allow magnetic levitation into a spacecraft. This report describes the floor and/or ceiling made of diamagnetic permanent magnets. We report how current through the material could modulate the intensity of force. We also discussed the

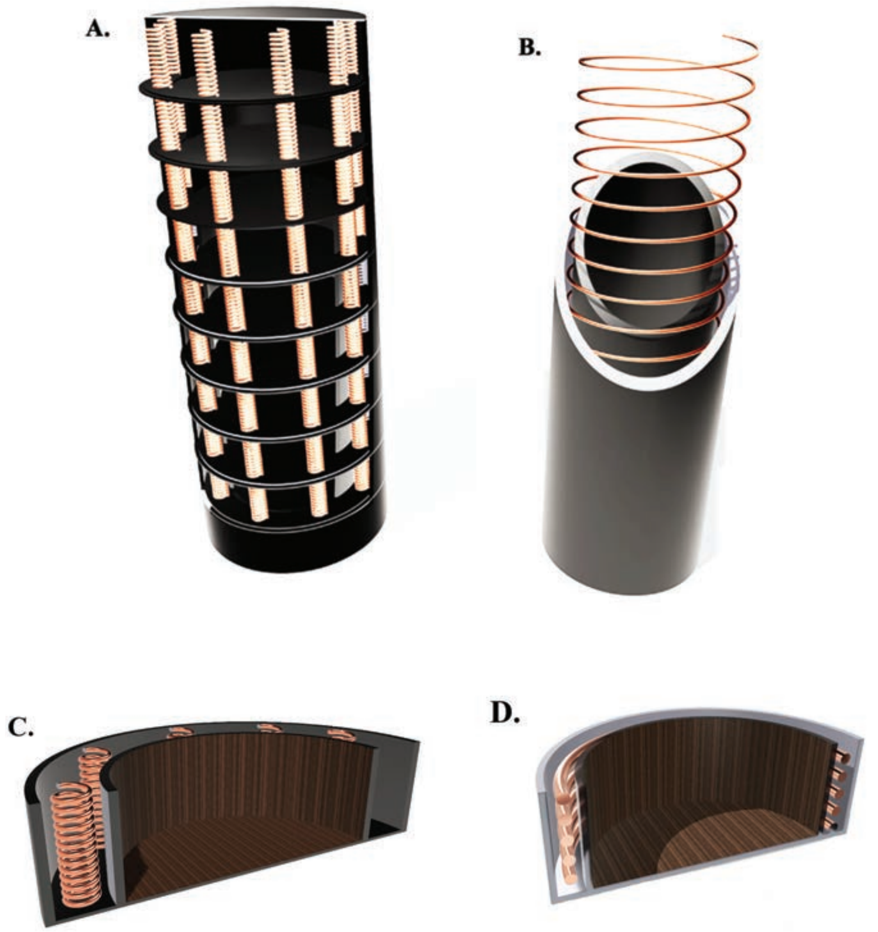

Figure 1 3D Model of 1- and 10-coil generator. **(A)** Shows how the coil's arrangement would be placed in a 10-coil system. **(B)** Image depicts 1-coil arrangement. This model favors height over length/width for a spacecraft/module. **(C)** Image depicts a smaller version of the 10-coil arrangement made for 1 floor. **(D)** The image shows the coil's arrangement in a one coil system. This model is most useful in more mainstream spaceships.

diamagnetic permanent magnet and proposed that this method would be more suited for a wider layout, rather than a height or multiple levels of a ship.

There are a couple of limitations that might not make this method viable for space application. First the size might not be suitable for a small spaceship. The amount of force that would be exerted through this smaller magnet would not be enough to maintain organisms and objects on a surface.

Also, during the installation or depending on the way that the coils are placed around the magnet, the latter might be cracked, which would create new poles with the broken magnet flying in two different directions.

Advantages of Artificial Diamagnetic Levitation

Diamagnetic levitation can be applied to humans and objects due to the fundamental principles of magnetic repulsion and the unique properties of diamagnetic materials. When subjected to a magnetic field, diamagnetic materials exhibit a repulsive force, causing the objects to be pushed from the magnetic field. Strategic creation of magnetic fields in a spacecraft could generate a repulsive force that counteracts the effects of microgravity by simulating a gravitational-like force. This would allow humans and objects to experience gravity analogous to gravity on earth. If so, this would make it easy for humans to travel back and forth to other planets without the long adjustment. Furthermore, by utilizing appropriate diamagnetic materials and designing the magnetic fields accordingly, it would be feasible to achieve stable levitation to create an environment that mimics the effects of gravity.

Achieving Diamagnetic Levitation

To reiterate, diamagnetic levitation involves the use of a magnetic field to achieve the levitation of objects such as stabilizing a human on a flat surface in space. Diamagnetic materials, including copper, silver, gold, and bismuth. These materials exhibit weak responses to magnetics or electromagnetic fields [17]. Repulsion would occur if these materials were subjected to magnetic fields, like two magnets with the same polarity placed together. This repulsion occurs because the electrons in diamagnetic materials rearrange their orbits, generating currents that oppose the external magnetic field [18]. In contrast, paramagnetic materials such as aluminum, platinum, and gadolinium are weakly attracted to magnetic fields [18].

The magnetic fields generated by diamagnetic materials vary depending on their composition and shape, leading to fluctuations and non-uniformity. For instance, a spherical diamagnetic material will produce stronger magnetic fields at its poles and weaker fields at its center, resembling the magnetic field of the earth. However, efforts can be made to minimize these variations through careful design and calibration of the magnetic field. Alternative approaches such as rotating habitats or centrifuges are often deemed more effective due to their consistency and lack of power. Still, these approaches are only suitable to be used in a bigger spacecraft or space station.

Mitigating Diamagnetic Levitation Limitation

Consideration of a particular model must discuss the limitations. Permanent magnets, if broken or cracked in space, can render the generator unusable and even damage the ship. Additionally, finding a magnet large enough to apply the necessary force against massive objects can be challenging. Figure 2A shows a visual representation by which force could be regulated by a current that is applied in two different directions. Indeed, this would be applicable to any size of a spaceship.

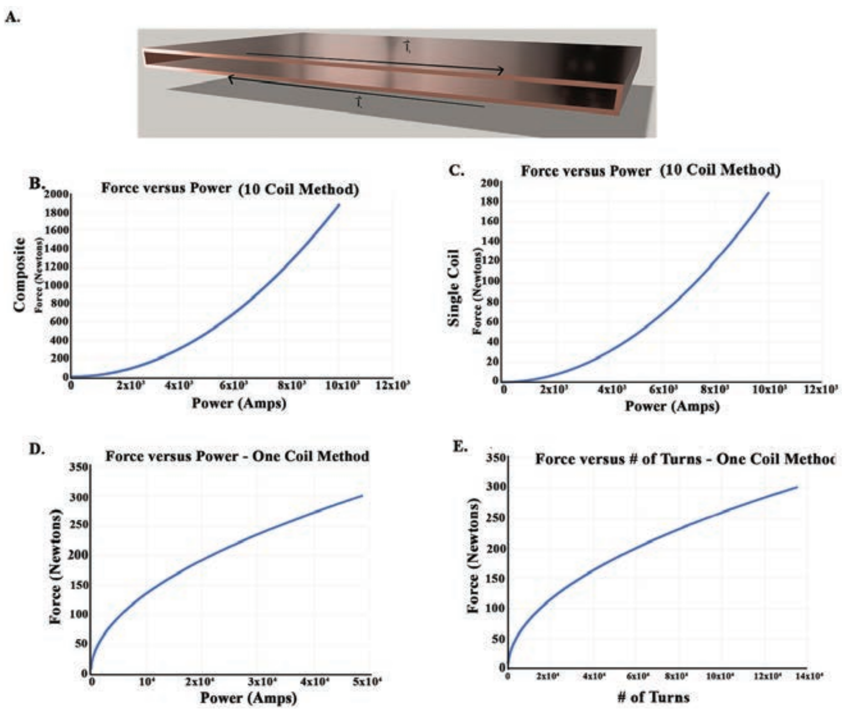

Figure 2 3D model of 2 permanent magnets and force vs. power and number of turns. **(A)** The image demonstrates how 2 permanent magnets can be positioned on top of each other to create artificial gravity. The magnets are subjected to two currents in opposite directions. **(B–E)** Figure demonstrates the relationship between power and force as described in the results section. The figure is the composite of force exerted by the 10 coils **(B)**. The graph demonstrates the relationship between the force of one coil standing alone and the power inputted into the system **(C)**. Shown is relationship between # of turns and force created by the generator with the number of turns constant at 300 turns **(D)**. The graph depicts the relationship between # of turns and force created by the generator while maintaining a constant power of 1000 amps **(E)**.

Optimizing Power to Generate Artificial Gravity

We developed studies to optimize the relationship between force, amperage, and number of turns. First, we tested the 10-coil method using the following equation:

$$\mathrm{F} = \frac{\mu 0 \times \mathrm{I1} \times \mathrm{I2} \times \mathrm{N1} \times \mathrm{N2} \times \mathrm{A}}{2 \times \mu \times \mathrm{r}}$$

The equation calculates the amount of force between 2 coils. $\mu 0$ is the permeability of free space, I1 and I2 are the currents in the two coils, A is the area of each coil, r is the distance between them, and N1 and N2 are the number of turns between each coil.

We combined the amount of force in the 10 coils by measuring the force between two coils in a 10-coil system (Figures 1A and 1C). This resulted in approximately 1000 N of force, which required approximately 6000 Amps (Figure 2B). If we calculated the same force except within one coil, this resulted in 10 times less force with the same level of power (Figure 2C).

The magnetic fields by a 10-coil method are likely to interrupt the individual coil. Moreover, the force was calculated outside of the coil, which could not recapitulate how humans would be affected within the 10 coils. We therefore repeated the analyses using the 1-coil method, which provided us with the power to evaluate the force inside where living organisms could survive (Figures 1B and 1D). Using the same equation used in the 10-coil method, we deduced that 300 turns would require approximately 430 Amps (Figures 2D and 2E). Although this seems to be almost equivalent to the 10-coil method (Figure 2B), the advantage is the predicted stability since the multiple coils will not interfere with each other. These analyses might vary with changes of space. This section described predicted outcome in which the 10-coil method showed not advantage over the 1 coil method whereas the latter could mitigate untoward effects of coil-coil interference of the 10-coil system.

Simulation of Gravity Versus Magnetic Field

The simulations shown in Figure 2 indicated that the 1-coil method could be advantageous to achieve 'livable' gravity. We validated this using another method. Specifically, we took a cross section of the 1 coil shown in Figure 1D and import into FEMM [19]. This software predicts the magnetic intensity in small circular sections. The result showed less magnetic intensity toward the center suggesting a livable space with gravity and reduced magnetic intensity (Figure 3A).

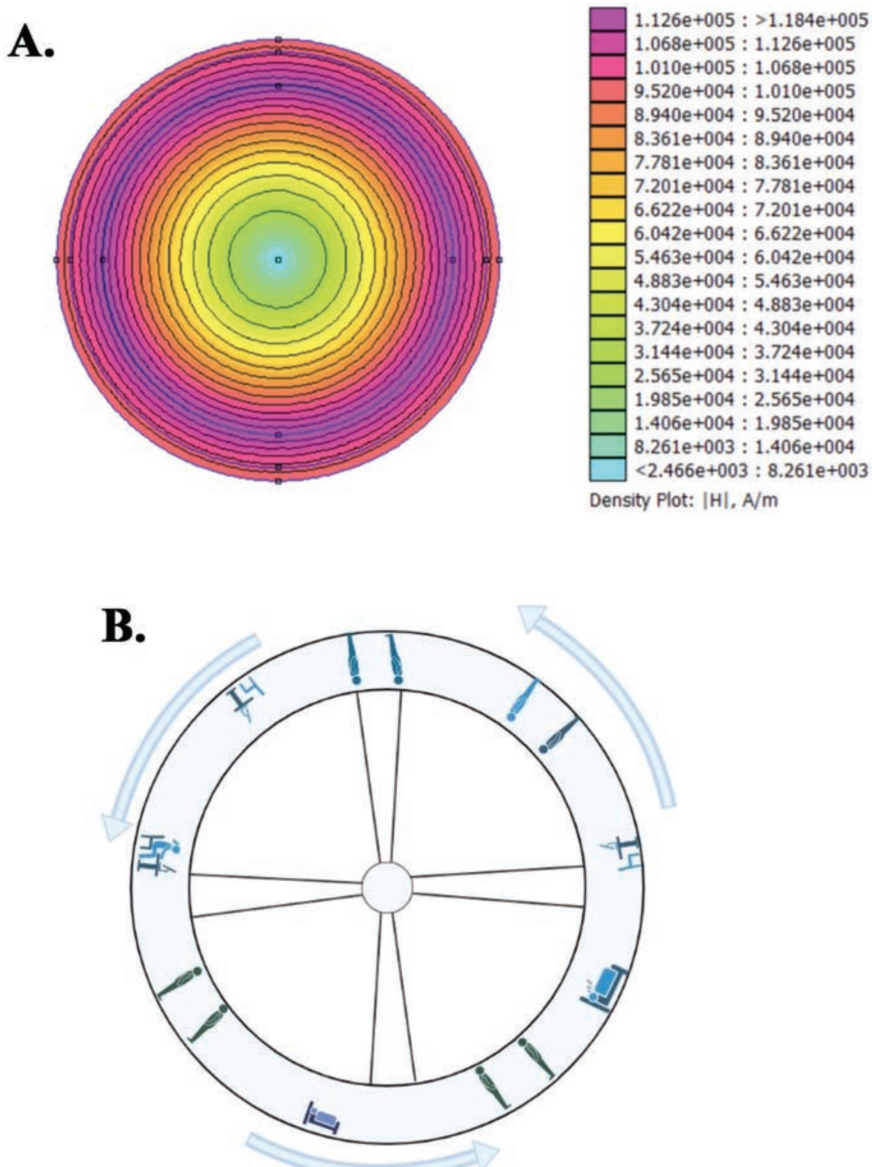

Figure 3 One Coil Field Intensity and centrifugal force. **(A)** This image shows the intensity of the magnetic field in Amperage per meter. The actual coil's radius is the 2nd prominent dot from the middle to the outer dot. This was simulated through the FEMM simulation software. **(B)** Centrifugal force can create artificial gravity by rotating the outer part of a spaceship around an axis.

Alternative Method to Acquire Artificial Gravity

Centrifugal force and rotating habitats have been shown to provide gravity [20] (Figure 3B). However, this type of application could be limited to large spaceships or space stations. It would be highly inapplicable for a small spaceship due to the speed of rotation and the size of the rotor.

Specific Consideration

The results thus far show predicted models that could be used to mitigate gravity where humans were limited to explore. Figure 4A shows a brief timeline of the history of artificial gravity [21]. Indeed as far as we know, the first experiment in space occurred in 1966 with the Gemini XI Mission [13]. This was remarkable considering the limited information on methods to mitigate low gravity and, with less advanced healthcare faced by the returning

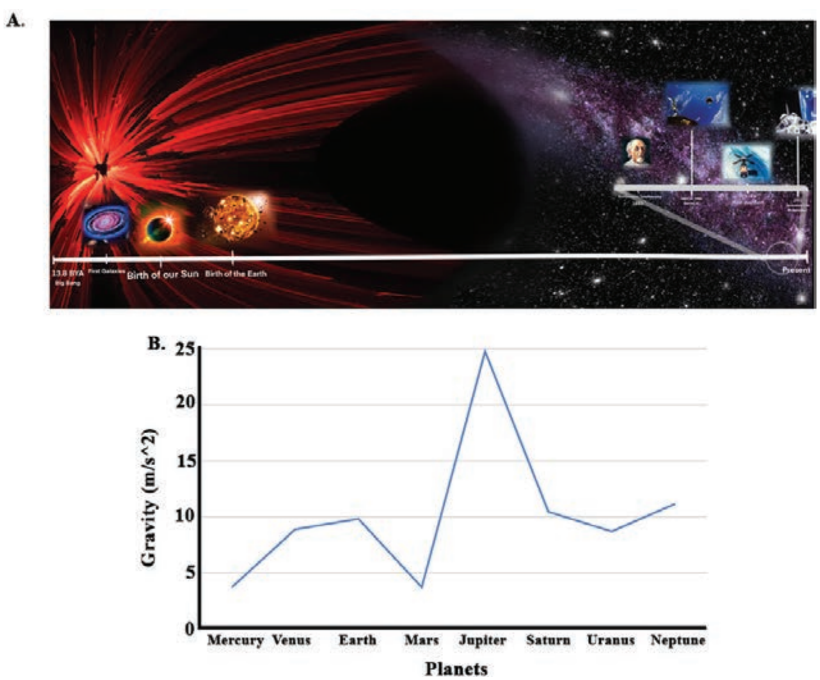

Figure 4 Timeline of the history of artificial gravity and gravity of planets. **(A)** The first recording of experiment in space with the Gemini XI Mission in 1966 to date showing the need for research. **(B)**. The graph shows the amount of gravity that each planet exerts on an object on or around.

astronauts. The timeline shown in Figure 4A briefly includes the start of time to display the impact of how little research and technology have been done on artificial gravity. A major consideration that would determine how the model is designed would require adjusting the model, depending on the targeted planet (Figure 4B). Microgravitational environments can be found primarily in space, but occasionally, some planets and the moon have limited mass thereby exhibiting microgravity. An example, the gravitational pull of the moon is one-sixth of the earth gravity [22]. To this end, we depicted the gravity of planets to demonstrate how such differences would be key when planning to modify the discussed methods to visit a specific planet gravity. Figure 4B shows the amount of gravity that each planet exerts on an object on or around [23]. Organic/natural gravity is determined by the mass and volume of an object. Humans and organisms adjust to earth's gravity of 9.81 m/s^2. The planet close to earth where humans could feel the same resistance as earth would be Venus. This force is also used in carnival rides such as the Graviton, where humans feel weightless as the ride spins around. While there might be some effects such as fluid redistribution, this is minimum.

A fundamental consideration is to understand that living objects have molecules, water and bones that could create levitations. In this regard, the desired levitation in a vehicle with various organisms will need to determine how a particular vehicle could use diamagnetic levitation to accommodate various living beings [18].

Non-ferromagnetic Materials

This section addresses the different types of magnetic materials [24]. Above, we discussed the diamagnetic materials that oppose magnetic fields to create gravitational generator. We introduce paramagnetic materials that are weakly magnetized by magnetic fields [25]. Ferromagnetic materials have the highest susceptibility and attraction to magnetic fields. The magnetic properties of ferrimagnetic materials depend on what temperature [26]. A ferrimagnetic substance is magnetic below the magnetization compensation point. The magnetic components cancel each other at the compensation point, resulting in a zero value for the overall magnetic moment. Ferrimagnetic materials have high resistivity and anisotropic characteristics.

The coil models shown in Figure 1 would need to consider the wall/coating between the objects and the generator/coil. This issue is important to prevent electrocution. Since several types of ceramics are diamagnetic [27], this could be beneficial for the generator. Such material would boost the coil's magnetic field, perhaps like placing a ferromagnetic material inside of a magnetic field.

Discussion

Artificial gravity has the potential to recreate earth's gravity in space. This type of gravity holds promise for a multitude of applications beyond spaceflight and space settlement. Among their applications are healthcare and biomedical research. Prolonged exposure to microgravity in space can have detrimental effects on human physiology, including muscle and bone loss, cardiovascular deconditioning, and impaired immune function. By introducing artificial gravity, either through rotating spacecraft or other innovative methods, we can mitigate these health risks and ensure the well-being of astronauts during extended missions. Artificial gravity could also prove beneficial for rehabilitation purposes on earth by aiding individuals recovering from injuries and surgeries in a controlled environment. This is particularly relevant for gradual regain of strength and mobility.

A major health issue is the association of microgravity with ocular health. Space-Associated Neuro-ocular Syndrome (SANS) has emerged as a significant issue for astronauts [28]. It involves ocular abnormalities, including optic disc swelling and flattening of the eye. Astronauts who embarked on long-duration missions, such as those on the International Space Station (ISS), have experienced symptoms such as blurred vision, difficulty focusing, and impaired near vision. Although the mechanisms of SANS remain unanswered, it has been proposed to be caused by microgravity-mediated fluid shifts and changes in intracranial pressure.

Potential Applications for Human Space

The development of diamagnetic gravitation will be important to determine study the effects of low gravity on human physiology, and to optimize if artificial gravity could mitigate the untoward effects. We do not foresee an immediate application in space. However, this study provides different platforms that scientists could use to dissect how gravity's effects biological processes. Scientists can develop multi- and inter-disciplinary teams to gain insights into how various gravitational forces affect physiological systems and specific organs with controlled artificial gravity. Intense research studies could be used to treat health issues associated with space travel such as osteoporosis, muscle atrophy, and balance [29].

In general, applying the basic models shown in this report could be a starting platform to study artificial gravity, and to determine how this could improve vertebrates' comfort and general well-being during extended space missions. Body fluids tend to move higher in microgravity, leading to physiological discomforts including facial puffiness and congestion. By promoting the natural circulation of physiological fluids and minimizing fluid changes and related discomforts, artificial gravity can offset these consequences. The crew's morale, productivity, and mission performance could all be significantly impacted by artificial gravity.

Potential Industrial Application

In addition to human well-being, artificial gravity holds potential for a variety of industrial applications. The effects of gravity can be extremely important for manufacturing operations that entail the handling of delicate and sensitive materials. The location of items can be controlled and stabilized using artificial gravity. This would enable more accurate and effective manipulation during assembly, production, or testing. Artificial gravity can also simplify and accelerate procedures in space-based manufacturing and construction since this will provide a comfortable atmosphere that requires dexterity and precision.

Predicted Relevance to Transportation

Diamagnetic levitation could be applied to the field of transportation; perhaps to create levitating vehicles that float over specially created tracks with diamagnetic levitation technology. These vehicles may travel without friction since the attraction between diamagnetic materials and powerful magnetic fields to achieve lower energy usage and higher efficiency. The idea of high-speed, comfortable, and environmentally friendly travel has been referred to as "maglev" technology. This application is already in use with bullet trains [30]. These trains use diamagnetic levitation to levitate their trains and make them travel up to 320 km/hr ($\sim$200 mph) [31].

Modification of the Coil Model – Relevance to Humans in Space

Our described model of artificial gravity showed the potential to mitigate low gravity in a spacecraft (Figures 1–3). By placing the diamagnetic material on the outside/in the hull, and keeping the paramagnetic material on the floor, the diamagnetic material stabilizes living beings and objects on surfaces. One

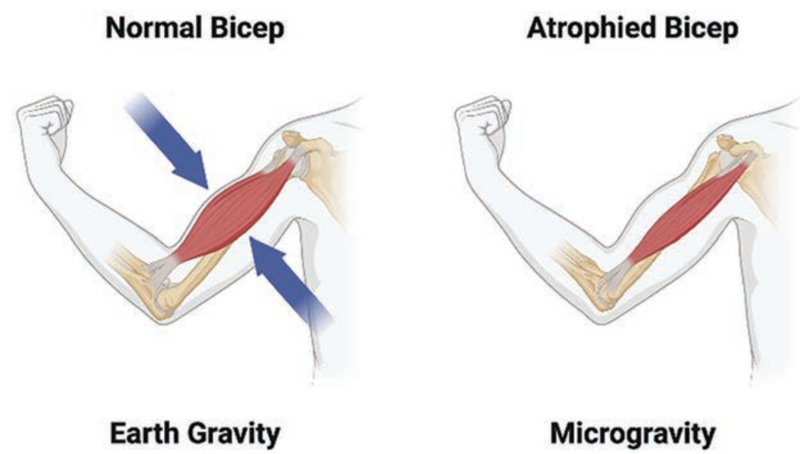

Figure 5 Effect that microgravity on the human muscle. Shown is a profound impact on the human musculoskeletal system. In microgravity, the body no longer experiences force, leading to muscle atrophy (right). Countermeasures described in this study could mitigate the negative effects for maintenance of a healthy state (left). The figure was developed with BioRender.

could place the diamagnetic coil along the top/roof to allow for electrical current through the materials. This might be able to change the strength of the magnets to facilitate gravity within the location of living beings and objects. These methods would allow humans to make long trips to mars, and even into the great cosmos, without major consideration of long-term effects caused by microgravity. Indeed, this would have to adjust to the planet since they each have varied levels of gravity (Figure 4B).

Modification of the coil methods would be relevant to one of the prominent challenges caused by microgravity – muscle atrophy in which the muscles rapidly weaken and lose their strength due to the absence of regular resistance provided by gravity [32] (Figure 5). Artificial gravity addresses this problem by recreating a gravitational force through methods such as rotating habitats or diamagnetic levitation. Reintroduction of resistance and simulating gravity, artificial gravity could mitigate muscle atrophy and ensures that the muscle maintains resistance to gravity. This would allow astronauts to maintain their muscle mass and strength, facilitating a smoother transition when returning to earth, and allowing them to stay longer in space.

The cardiovascular system also faces challenges in microgravity. The absence of gravity alters blood flow distribution and compromises cardiovascular conditioning [33]. Artificial gravity provides a solution by simulating gravitational force to maintain normal blood flow distribution and cardiovascular health. By subjecting a living being to gravitational force with artificial gravitational techniques, the live being such as astronauts can preserve their cardiovascular fitness as well as preventive care.

Additionally, artificial gravity can help address the problem of bone density loss in microgravity [34]. In the absence of gravity's stress on the skeletal system, bone density diminishes, leading to bone weakening and increased susceptibility to fractures. Artificial gravity counteracts this problem by reintroducing resistance to the bones. By subjecting the body to a simulated gravitational force, artificial gravity could maintain bone density and strength, reducing the risk of bone-related health complications. Along with muscle atrophy, these problems can cause highly detrimental effects on humans, sometimes permanent for poor quality of life. Furthermore, artificial gravity assists in mitigating the effects of fluid shifts caused by microgravity [35]. In weightlessness, bodily fluids tend to accumulate in the upper body, leading to facial puffiness, vision impairment, and cardiovascular strain. Artificial gravity helps restore the natural distribution of bodily fluids by simulating gravity's pull. By creating a consistent gravitational force, artificial gravity aids in fluid regulation, minimizing facial swelling, preserving visual acuity, and alleviating cardiovascular strain.

Conclusion

Overall, artificial gravity offers a comprehensive solution to mitigate the challenges posed by microgravity. By reintroducing a simulated gravitational force, artificial gravity could combat muscle atrophy, maintains cardiovascular health, preserves bone density, and regulates fluid distribution. These benefits contribute to the well-being and adaptability of astronauts during space missions and facilitate a smoother transition when returning to earth. Time away from a stable gravity environment is proportional to untoward effects on humans. As outlined in this report, maintaining humans with artificial gravity would greatly reduce health impact. Artificial gravity could go beyond the coil models that are described in this report. Simulating gravitational force through techniques such as rotating habitats or diamagnetic levitation could lead to stable artificial gravity.

The potential use of diamagnetic levitation to create artificial gravity has been examined in this report. While alternative strategies, such as centrifugal force, have been considered, diamagnetic levitation has advantages with the potential to be a viable option. Diamagnetic levitation offers a practical alternative for routine space travel, enabling the efficacy of artificial gravity.

We have examined the basic ideas of diamagnetic levitation and investigated how its development can facilitate clinical issues associated with microgravity. We discussed the potential limitations that could affect efficacy. Artificial gravity can offset muscle atrophy and other negative effects by creating a repelling force with diamagnetic materials, boosting health and well-being during space missions. The development of the described technology has much potential for human to safely visit space.

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