Key Determinants in Space Science Experimentation

By Terry Tang

Space Science is defined as:

1. Anyofseveralscientificdisciplines,suchasexobiology,thatstudypheno menaoccurringintheupperatmosphere,inspace,oroncelestialbodiesother thanEarth.

2. Adisciplinerelatedtoordealingwiththeproblemsofspaceflight.[1]

Knowing how electromagnetic, gravity, and life energy forces function and interact is crucial for enabling humans to survive in Space's micro-gravity.

With James Maxwell's magnetic equations and theories, one can calculate electro nuclear forces in or around human living cell atoms to create instruments controlling gravity so that human life is not affected when gravity changes from Earth to Space.

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At the National Geographic Channel Ceremony for 2016 on November 8, 2015, the Breakthrough Prize in Mathematics was awarded to Ian Agol; in Life Sciencesit was awarded to Edward S. Boyden, Karl Deisseroth, John Hardy, Helen Hobbs, and Svante Pääboin; andin Fundamental Physics it was awarded to leaders andmembers of experiments on Neutrino Oscillation in China, Japan, and Canada.[2]"By challenging conventional thinking and expanding knowledge over the long term, scientists can solve the biggest problems of our time.…The Breakthrough Prize honors achievements in science and math so we can encourage more pioneering research and celebrate scientists as the heroes they truly are," Mark Zuckerberg said.

"Space needs another *Moon Shot*, Google's Government Innovation Labs initiative to bring about audacious moonshot thinking involving partnering and collaborating in humanity's never ending search for innovations for improving how we live," many think.

This manuscript is a continuation and expansion of "Milestones to Space Settlement – An NSS Roadmap Part IV:To the Moon, Particular Barriers,"[3] Sections 1:Biological—radiation and gravity 1/6th Earth's and 2: Psychological andpolitical, addressed in this paper, *specifically MILESTONE 11: A Lunar Research Facility* to study human habilitation, test equipment and techniques, and conduct lunar investigations.

[1]American Heritage® Dictionary of the English Language, 5th ed. (Boston: Houghton Mifflin Harcourt, 2011).
[2]breakthroughprize.org/News/29.
[3]*adAstra* (Spring 2014): M12-M15.

The Moon's gravity is 1/6th of the Earth's,the Moon's mass is 1.23%of the Earth's, the moon's density is approximately 60.6% of the Earth's, and the Moon is approximately 27% the size of the Earth,*which is much larger than of ISS.Larger mass means more resources for constructing shields against radiation and more gravity for enabling longer-duration living with optimal vitality when gravity is less than that of Earth's.Larger mass also means more resources and more area for constructing instruments for controlling electromagnetic and life energy forces.*

An Experiment in Progress

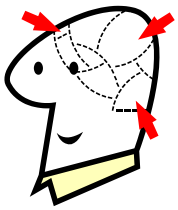
US astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko are on the ISS,scheduled to return to earth March 2016 after completing aone-year mission on how a long space stay affects them.Kelly's identical twin former astronaut brother–with the same genetics – concurrently studied on Earth under similar experimental conditions to control for genetics while studying gravity's effect on humans:thein-space data will be compared with the on-Earth data toidentifychanges caused by living in Space.Scott and Mikhail, in turn, will be joined by rotating other ISS astronauts in Space from periods ranging from 10 days to six months as part of the one-year missionexperiment.[4]

Envisioning More Experiments

Thisone-year missioncan be expanded to include a third,experimentally yoked condition with astronauts on the Moon,where they are likely to be healthier than on the ISS, because the Moon has more gravity than ISS.

Envisioning Your Experiment

Gilbert Ryle (1900-1976), the British philosopher of anti-dualism, distinguished between knowing that and knowing how. Most knowledge is declarative and states that something is the case. *Far rarer, and usually of greater practical utility, is the procedural knowledge explaining how to do something or how it comes about*. Most theory and research takes it as a given that a person with a plan, a leader, creates, shapes, and maintains organizational structures for accomplishing a goal. The important question is just how might they, or might we and or others,do it?Thoughts, Concepts, Cognitions?



Increasingly, Space Science encompasses exobiology, and the disciplines related to or dealing with problems of space flight include cognitive science, computer science,neuroscience, psychology, genetics, and epigenetics.Global research is providing a clearer understanding of how brains and nervous systems develop and change both naturally and under stress and other demanding conditions.We need someone to learn something – say with scientific experimentation on how the human body learns, develops, and adaptsto internal and external stressors, both on Earth and in Space.

[4]Jeffrey Kluger, "Mission Twinpossible," *Time* 184, no. 26-27 (2014): 34-38.

Fundamentally this is about protecting the body from external stressors and about enabling the creation and strengthening of neural networks in the body's central and peripheral nervous systems.Studies being published daily are stunning in their details and results, as the 2016 Breakthrough Prizes indicated, e.g., in *optogenetics*,a biological technique that involves the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels.

Funding Your Experiment

The ISS US National Laboratory's research platform, CASIS, regularly provides solicitation opportunities in the life, physical, materials, and observational sciences.*It welcomes unsolicited proposals for research and product development*that might be suitable for the National Lab.The CASIS mission is to utilize the National Labfully, enabling cutting-edge research on the station from every corner of the country.[5]

For example, NASA's Physical Science Research Program will fund seven proposals to conduct physics research using the agency's new microgravity laboratory scheduled to launch to the ISS in 2016.This cold atom laboratory will provide an opportunity to study ultra-cold quantum gases in the microgravity environment of the ISS– afrontier in scientific research that is expected to reveal interesting and novel quantum phenomena, becauseatoms can be observed over a longer period, and mixtures of different atoms can be studied free of the effects of gravity, where cold atoms can be trapped more easily by magnetic fields.The chosen proposals came from seven research teams in response to NASA's research announcement "Research Opportunities in Fundamental Physics." The proposals will receive a total of about $12.7 million over a four- to five-year period, which will begin immediately.[6]

If you have an idea for a government project, you may not have to wait for a request for proposal that matches your dream contract before you start writing your proposal. The federal government and its associated agencies will not rule out an unsolicited proposal, because they have a stated interest in receiving proposals that contain new ideas and innovative concepts pertaining to their program areas.[7]

An unsolicited proposal is a written but informal bid, proposal, or quotation submitted on the initiative of the submitter and not in response to any formal or informal request.It may be submitted to any potential funding and research support group, governmental organization, or nongovernmental organization.

Networking and interpersonal contacts may assist in identifying potential funding and experimental support, e.g., by being an active member of National Space Society[8] or other organizations or by consulting with others such as your US Member of Congress,

[5] www.iss-casis.org/opportunities/unsolicitedproposals.aspx.
[6] www.jpl.nasa.gov/news/news.php?feature=4030.
[7] www.onvia.com/business-resources/unsolicited-proposals-what-you-need-know#sthash.SdmNJV1o.dpuf.
[8] www.nss.org.

who may be on or know members of the Committee on Science, Space, and Technology[9] to listen to concerns and provide assistance.

Motivation

Psychological and political barriers are resolvable with guidance from synergy theories,[10] and organizations such as the United Nations.The United Nations uses six official languages augmented with organizational operations andprocedures, committees, groups, rules, regulations, and electronic devices guided by history, practice, politics, theories, and intelligence algorithms.Motivation increases when barriers are overcome.

Language is a primary force connecting human individuals by facilitating communication of cognitions, concepts, and denotations, which enable science to progress.How language affects science is theorized by philosophers.One theory is the constructivisttheory that says that scientists construct mental models to understand the world around them and that this happens most effectively when they conduct experiments.Science is the experience of scientists reconstructing the phenomenon being investigated and the transmission of this knowledge.

Human research is most effective when the experience constructs a meaningful product that is denotatively communicated accurately to others globally.

Linguistic relativityholds that the structure of alanguageaffects the ways in which its respective speakers conceptualize their world, i.e., their world view, or otherwise influences theircognitive processes. Popularly known as theSapir–Whorf hypothesis, orWhorfianism, the principle is often defined to include two versions: the strongversion states that language determines thought and that linguistic categories limit and determine cognitive categories;the weakversion states that linguistic categories and usage influence thought and certain kinds of non-linguistic behavior.

Linguistic or communicative relativity can be controlled with mathematics and other forms of symbolic logic, imagery, cognition, or neuronal activity, signal detection (e.g., Bayes criterion),etc., by intelligence algorithms, by various instruments denoting measurements,[11] and by mathematical formulations and processes.[12]New electronic instruments and tools can be created for assisting scientists.[13]

What policy will support international Moon infrastructure?How can the work involved be framed so that the global public understands and appreciates the value added?How might global entities respond to cultural differences and contexts?

Noam Chomsky indicated that global agreement is not possible:artificial intelligencewill never be able to obtain an algorithm for cognition, i.e., artificial intelligence translations

[9] science.house.gov/about/membership.
[10] See, for example, wikipedia.org/wiki/Synergy.
[11] See, for example, C. Joseph (Ed.),*A Measure of Everything*(New York: Firefly Books, 2005).
[12] See, for example, D. Darling, *The Universal Book of Mathematics*(Hoboken, NJ: Wiley, 2004).
[13] See, for example, S. Gibilisco,*Electricity and Electronics*(New York: McGraw-Hill, 1997).

of languages will always be inadequate.[14]Noam Chomsky discredited behaviorism and became a founder of modern linguistics (and/or cognitive science).

The United Nations, however, continues to attempt to fulfill its mission statement:

> WE THE PEOPLES OF THE UNITED NATIONS DETERMINED
> - to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and
> - to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small, and
> - to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and
> - to promote social progress and better standards of life in larger freedom.[15]

*This last item can be continued on the Moon and in Space to resolvethe NSS Roadmap's, psychological andpoliticalbarriers*asdiscussed in "Milestones to Space Settlement."

In studying the effects of space on human physiology, evaluating risks vs. benefits is crucial.Living in space and spending time in microgravity is known to have serious effects on the human body, witnessed by astronauts within months with all available precautions taken, e.g., two hours of vigorous exercise daily, etc.[16]

As researchers, theoreticians, physicists, and Space Scientists in the Americas, Europe, Asia, and everywhere globally study and discover new laws orconcepts of physics, exobiology, and cognition, scientific experimentation is required for understanding and sharing the innovations.

Pursuant to *Constructivist*Theory,scientists understand the world most effectively when they conduct experiments.Many experiments have been conducted to affirm the nature of *binding energy*, described as follows:

> In general, binding energy represents themechanical workthat must be done against the forces which hold an object together, disassembling the object into component parts separated by sufficient distance that further separation requires negligible additional work.
>
> At theatomic leveltheatomic binding energyof the atom derives fromelectromagnetic interactionand is theenergyrequired to disassemble an atom into free electrons and a nucleus.Electron binding energyis a

[14]Socrates, "Noam Chomsky: The Singularity is Science Fiction!"www.singularityweblog.com/noam-chomsky-the-singularity-is-science-fiction.
[15]www.un.org/en/documents/charter/preamble.shtml.
[16]See Kenneth Chang, "Beings Not Made for Space," www.nytimes.com/2014/01/28/science/bodies-not-made-for-space.html.

> measure of the energy required to free electrons from their atomic orbits known as ionization energy.…
>
> Inastrophysics,gravitational binding energyof a celestial body is the energy required to expand the material to infinity.[17]

This quantity should not be confused with the*gravitational potential energy*, which is the energy required to separate two bodies, such as a celestial body and a satellite, to infinite distance, keeping each intact (the latter energy is lower).

> Thegravitationalbinding energyof an object consisting of loose material, held together by gravity alone, is the amount ofenergyrequired to pull all of the material apart, to infinity. It is also the amount of energy that is liberated (usually in the form ofheat) during theaccretionof such an object from material falling from infinity.
>
> The gravitational binding energy of a system is equal to the negative of the totalgravitational potential energy, considering the system as a set of small particles. For a system consisting of a celestial body and a satellite, the gravitational binding energy will have a larger absolute value than the potential energy of the satellite with respect to the celestial body, because for the latter quantity, only the separation of the two components is taken into account, keeping each intact.[18]

For a sphericalmassof uniformdensity, the gravitational binding energy*U*is given by the formula

$$U = \frac{3GM^2}{5r}$$

where*G*is thegravitational constant,*M*is the mass of the sphere, and*r*is its radius. This is 80% greater than the energy required to separate to infinity the two hemispheres of the spherical mass.

> Atomic ionization energy can be predicted by an analysis usingelectrostatic potentialand theBohr modelof the atom, as follows (note that the derivation uses Gaussian units).
>
> Consider an electron of charge-*e*and an atomic nucleus with charge+*Ze*, where*Z*is the number of protons in the nucleus. According to theBohr model, if the electron were to approach and bind with the atom, it would come to rest at a certain radius*a*. The electrostatic potential*V*at distance*a*from the ionic nucleus, referenced to a point infinitely far away, is:

[17] en.wikipedia.org/wiki/Binding_energy.
[18] www.fxsolver.com/browse/formulas/Gravitational+Binding+Energy+-+spherical+mass+of+uniform+density.

$$V = \frac{Ze}{a}$$

Since the electron is negatively charged, it is drawn inwards by this positive electrostatic potential. The energy required for the electron to "climb out" and leave the atom is:

$$E = eV = \frac{Ze^2}{a}$$

This analysis is incomplete, as it leaves the distance*a*as an unknown variable. It can be made more rigorous by assigning to each electron of everychemical elementa characteristic distance, chosen so that this relation agrees with experimental data.[19]

Inmathematics, aGaussian function(named afterCarl Friedrich Gauss) is afunctionof the form:

$$f(x) = a \exp\left(-\frac{(x-b)^2}{2c^2}\right) + d$$

for arbitraryrealconstants*a*,*b*,*c*,*d*.

Thegraphof a Gaussian is a characteristic symmetric "bell curve" shape.[20]

This curve quickly falls off towards zero.

String theory was first studied in the late 1960s as a theory of thestrong nuclear forcebefore being abandoned in favor of quantum chromodynamics. Subsequently, it was realized that the very properties that made string theory unsuitable as atheory of nuclear physicsmade it a promising candidate for aquantum theory of gravity.[21]

In theoretical physics, quantum chromodynamics (QCD) is a theory of strong interactions, a fundamental force describing the interactions between quarks and gluons which make up hadrons such as the proton, neutron and pion. QCD is a type of quantum field theory called a non-abelian gauge theory with symmetry group SU(3). The QCD analog of electric charge is a property called *color*. Gluons are the force carrier of the theory, like photons are for the electromagnetic force quantum electrodynamics. The theory is an important part of the Standard Model of

[19] en.wikipedia.org/wiki/Ionization_energy.
[20] en.wikipedia.org/wiki/Gaussian_function.
[21] en.wikipedia.org/wiki/String_theory.

> particle physics. A huge body of experimental evidence for QCD has been gathered over the years.[22]

There are several methods for generating artificial gravity, including(1)rotation, (2)linear acceleration, (3)mass, (4)magnetism, and (5)gravity generator/gravito-magnetism:[23]

> A number of methods for generating artificial gravity have been proposed for many years, as well as an even larger number ofscience fictionapproaches using both real andfictitious forces.Practicalouter spaceapplications of artificial gravity for humans have not yet been built and flown, principally due to the large size of the full-scale spacecraft required to allowcentripetal accelerationrotating spacecraft.[24]

Such large centripetal accelerationrotating spacecraft may be more readily built with the Moon as a mass density foundation than being without one in Space.

> Withoutg-force,space adaptation syndromeoccurs in some humans and animals. Many adaptations occur over a few days, but over a long period of time, bone density decreases, and some of this decrease may be permanent. The minimum g-force required to avoid bone loss is not known—nearly all current experience is with g-forces of 1g(on the surface of the Earth) or 0 g in orbit. There has been insufficient time spent on the Moon to determine whether lunar gravity is sufficient.The one-year mission experiment described above is expected to provide answers to many of the concerns identified in Beings Not Made forSpace."[25]

It has been said that necessity is the mother of invention, so when humans decided to build and inhabit a laboratory in the harsh environment of space, it was only natural that innovations would follow."Microgravity-Related Patent History," by Mark Uhran, looks back at the more than 818 patents granted since 1981.He uses patents as an indicator of value creation signifying economic growth potential.[26]

Maxwell's equations describe how charged particles give rise to electric and magnetic force per unit charge, a *field*. Particles can be stationary or moving. These, with Lorentz's equation, enable the calculation of the motion of particles in electric and magnetic fields needed for bone and human vitality as gravity changes from Earth to Moon.

Although earth, moon, and human densities differ, synergistic human relationships facilitate knowing more about biochemical processes involved in controlling human vitality as gravity changes.

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[22] en.wikipedia.org/wiki/Quantum_chromodynamics.
[23] en.wikipedia.org/wiki/Artificial_gravity#Methods_for_generating_artificial_gravity.
[24] en.wikipedia.org/wiki/Artificial_gravity#Methods_for_generating_artificial_gravity.
[25] See note 16 above.
[26] www.nasa.gov/mission_pages/station/research/news/microgravity_research.html.

Diamagneticmaterials create a*magnetic field*in opposition to an externally applied magnetic field. It is a quantum mechanical effect that occurs in all materials.Most material's diamagnetism is weak, but a*superconductor*repels the magnetic field entirely.In 2009, NASA's Jet Propulsion Lab levitated mice with such fields.[27]Perhaps being active in this cyberspace facilitates synergy,levitatingenergy and cognition for exploring Inner and Outer Space!

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About the Author: Terry Tang, PhD, is the director of Research for Kepler Space Institute. He is a Life Member, American Psychological Association, licensed psychologist with National Provider Identifier and a consultant in clinical and medical, research and forensic psychology. He has 35+ years working in three California State Hospitals, two Veterans Administration Hospitals, and three private hospitals. Faculty memberships were in Human Factors, University of Southern California Study Centers in California, Asia and Marshall Islands and in Experimental & General Psychology, Chinese University of Hong Kong, Ohlone College, and Pepperdine University. He was Researcher III, California Department of Corrections; Researcher, Public Systems Research Institute, USC, and Medical Advisor, Office of Hearings & Appeals, Social Security Administration.

Editors' Notes: Dr. Terry Tang is Kepler Space Institute's Director of Research. This article uses the current ISS one-year residence study of astronautsScott Kelly and Mikhail Kornienko to provide readers theory and guidance on Space experiment design. He uses experiments to study binding energy as examples. ***Bob Krone and Gordon Arthur*.**

[27] articles.latimes.com/2009/sep/12/nation/na-floating-mice12.