Physics of the Impossible

by Michio Kaku (Anchor Books)

Part I: Class I Impossibilities

• "*Class I impossibilities*" are technologies that are impossible today, but do not violate the known laws of physics. So they might be possible in this century (next 100 years), or perhaps the next (within 200 years) in some modified form:

1: Force Fields

I. When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.
II. The only way of discovering the limits of the possible is to venture a little past them into the impossible.
III. Any sufficiently advanced technology is indistinguishable from magic.
- Arthur C. Clarke's Three Laws

• The concept of "force fields" originated with Michael Faraday, a bookbinder who became interested in electricity and magnetism, and became secretary to famous physicist Humphrey Davy, and eventually eclipsing him.

• Faraday discovered "lines of force" by putting iron filings over a magnet, which physically oriented in lines.

• To Faraday "empty space" is not empty at all, but filled with lines of force, that could make distant objects move.

• Ignorant of mathematics, he used drawings to illustrate his force fields

• One day upon moving a magnet over a coil of wire that a current was produced: the beginning of generators and motors.

• Einstein used this picture to formulate relativity, and others for string theory.

• The known force fields are: gravity, electromagnetism, the weak force and the strong force.

• Perhaps a fifth – plasma - force can be used like to make windows on a rocket ship. Plasma is a gas of charged particles.

• Another possibility is magnetic levitation using room-temperature superconductors, if they can be made at higher temperatures than at present.

2: Invisibility

You cannot depend on your eyes when your imagination is out of focus.

- Mark Twain

• Invisibility has long been a topic of science fiction. But physicists have long claimed that such an effect is impossible.

• James Clerk Maxwell took experimental results of electricity and magnetism as expressed by Faraday and formulated the magnificent Maxwell equations. Combining these Maxwell found the light is an electromagnetic wave.

• Many glasses and liquid are transparent because distance between atoms and molecules is large. Some solids can bee heated and cooled, making a random structure like glass – that allows light to pass.

• There are new "metamaterials" (Duke and DARPA), that they can eliminate all reflection and shadows, then they can render n object totally invisible to that (microwaves, or other) form of radiation. For a good invisibility material, the metamaterials should have a negative index of refraction.

• Can also project a background image on some object to render it invisible.

• Some predict that some type of device will be available within a decade or century.

3: Phasers and Death Stars:

Radio has no future. Heavier-than-air flying machines are impossible. X-rays will prove to be a hoax.

- PHYSICIST LORD KELVIN, 1899

The (atomic) bomb will never go off. I speak as an expert in explosives.

- ADMIRAL WILLIAM LEAHY

• The Death Star is a colossal weapon, the size of an entire moon, as depicted in a (fictional) Star Wars episode, in which (laser cannons) can vaporize an entire planet.

• In the same movie series are: light sabers, ray guns, and phasers. Possible?

• Many critics cried "IMPOSSIBLE"!!! But there are no laws of physics that make these items beyond future reality.

• For instance, in nature there are huge, powerful jets from black holes, supernova and gamma ray bursters that could have the effect of a "death star". Could they be co-opted?

• In mythology there are Zeus (lightening bolts), Thor (magic hammer), Mjolnir (lightening bolts), Indra (magic spear). Some analysts say pure imagination; others say ancient aliens, r other.

• Archimedes is credited to have constructed huge solar reflectors to burn attacking ships in the second Punic War in 214 BC. Hitler tried focusing powerful sound waves. Then H. G. Wells "War of the World" story and radio program, and lasers in "Goldfinger" movie. But, in fact, it was once believed that coherent light lasers impossible to create.

• But in 1953 the MASER (Microwave light) was invented, followed by the LASER (visible and other wavelengths), powerful coherent (in phase, single frequency, and aligned) light.

• Since then many types of lasers have been invented, some of which are very powerful. But what about sabers, phasers and death stars?

• Need for portable (powerful) power packs!!

• And seems impossible to create solid light sabers; light moves onward, not contained. Could possibly create a tube with plasma.

• Maybe a century or two is needed----

• Regarding DEATH STARS, though very powerful lasers have been created, they are nothing like these.

• Possibly use magnetic confinement, like the International Thermonuclear Experimental Reactor (ITER) for fusion reactors (not yet achieved). Hopefully can produce more energy than it consumes. But could never fuel a "death star".

• NUCLEAR FIRED X-RAY LASERS: Could only be used once, of course. Edward Teller, father of hydrogen bomb, conceived of X-ray laser idea.

An experiment in 1983 convinced Ronald Regan to start "Star Wars defensive shield" program.

• Physics of death stars: Perhaps in hundreds of thousands of years in future can make hydrogen bomb-powered X-ray lasers; launch and explode thousands in space while being directed at some planet. But why do so?

4: Teleportation

How wonderful that we have met with paradox. Now we have some hope for making progress.

- NEILS BOHR

I canna' change the laws of physics, Captain!

- SCOTTY, CHIEF ENGINEER IN STAR TREK

• Teleportation is the ability to transport a person or object instantly from one place to another, like "beaming" in Star Trek.

• Earliest mention of such activity would be from "The Iliad" or the Bible, where gods or spirits whish somebody away.

• Also, standard practice in "magic", which means actually not real, but a trick.

• Also found in Sherlock Holmes novels.

• To teleport someone you would have to know the exact location of ever atom, which seems to violate Heisenberg's uncertainty principle involving measurements.

• But quantum mechanics allows a "wave equation" to be written for particles, atoms and molecules. Schrodinger did this after someone suggested that particles could act as waves, so he devised a wave equation, which became Schrödinger's equation. He then solved the case of an electron in orbit around a proton, and found accurate energy levels better than that of the Bohr equation while on vacation with one of his many lovers.

• BUT, this wave character, uncertainty and jumping seems to be restricted to the atomic level. So does not apply to a large object as a while, like me.

• The EPR experiment. For an electron, for instance, two created as a system are still entangled, even at huge distances, and if something happens – like a measurement - to one of them, this affects the other immediately. Until this time both electrons are represented by a wave function that allows them all possible states.

• Even though information traveled faster than the speed of light, it is random; cannot send messages in such a way, only entanglement.

• Recently similar experiments have been done with atoms. A set of 3. And it is possible to instantly teleport information, but not he object for a coherent system.

• Also using Bose Einstein condensates at near absolute temperature.

• But though larger systems (atoms or a virus might be Class II impossibility) are being constructed and teleported, it may take centuries to transport large objects like humans, or never. Not a coherent system. Perhaps this is Class II impossibility.

• Quantum computers involve similar science, and still in infancy.

5: Telepathy

If you haven't found something strange during the day, it hasn't been much of a day.

- JOHN WHEELER

Only those who attempt the absurd will achieve the impossible.

- M. C. ESCHER

• Historically, mind reading has often been associated with gods; god can read our mind and answer prayers.

• If one could read the minds of others it would be possible to accumulate awesome wealth and power. And would be a possible threat to all.

• But basically thoughts seems to be private and invisible; from the deep past charlatans, swindles and the delusional humans have taken advantage of the naïve and gullible among us.

• Many performers use a planted person in the audience.

• Gamblers have the ability to look at the dilation contraction of people's eyes, responding to pleasure and the opposite, etc.

• Today scientists scan people's eyes and their motions to reach the subconscious, even before the scanned person understands some idea in consciousness.

• Any investigation puts the "spiritualists", who completely believe in the paranormal, and "scientist" who need definite proof against each other.

• "ESP" (extrasensory perception) is a term coined by researchers at Duke University in the mid 1900s.

• Using "Zener cards" almost all experiments gave negative results of ESP tests. A few test were ambiguous.

• In the 1970s both the Soviet Union and USA's CIA, investigated ESP for any possible advantage. In 1972 at Stanford Research Institute (SRI), large-scale investigations were made.

• After a review by American Institute of Research (AIR) of such programs in 1995, all were shut down.

• From a scientific perspective, advances were made in detecting and understanding brain wave within the brain. EEG

• BUT, these signals are extremely weak and basically "gibberish", indistinguishable from random noise.

• Further, our brains are not capable of receiving such signals from others. No "antenna". And even if receivable, impossible to unscramble. All classic physics suggests against the possibility of ESP.

• Others claim new force, the "psi" force.

• OK, but what about Quantum theory? Using PET and MRI instruments for brain scans?

• Perhaps one day MRI r other scanning device can get "broad outlines" of thought, but not details. Perhaps can detect lying. Normal lie detectors have been greatly discredited; unemotional people can escape, an many false signs for innocent.

• Later noticed to tell a lie one must: 1) suppress the truth and 2) invent some alternative story: = much brain activity in several areas, like frontal lobe and anterior cingulated gyrus (where conflict resolution takes place).

• Many people would like effective lie defector. But in act such a device would make social interactions impossible.

• Detectors are quite unable to resolve the billions of signals and background noise.

• Perhaps one day small, hand-held MRI units connected to a computer can pick up some type on information, but not many details. Vague outlines of thought.

• The brain is NOT like a computer, and thought is distributed over great areas. It is constantly rewiring itself.

• How about putting ideas into the minds of people? It is known that stimulating certain parts of the brain create specific sensations, such as thoughts related to religion. Creation of feelings of other self" could be interpreted as a demon, angel, extraterrestrial, or even god.

• Some people are now trying to map all (100 billion neurons of a brain and their interconnections.

• But it appears that though science can learn much more about the brain and how it functions, because thought is so decentralized, it might evade analysis and detection. Thus the challenge is both Class I and Class II impossibilities.

6: Psycho-kinesis

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because the opponents eventually die, and a new generation grows up that is familiar with it.

\- MAX PLANK

It is a fool's prerogative to utter truths that no one else will speak.

\- SHAKESPEARE

• Psychokinesis is "mind over matter", or the ability to move objects by thinking bout them. It is one of the most talked about and desired among those who advocate ESP.

• Concept used in much literature and movies, including "the Force, in Star Wars.

• A famous event took place on the Johnny Cason show during he appearance of UrI Geller and the Amazing Randi, who provided his own spoons. Geller could not bend them, and Randy later showed how this bending trick is done.

• Later Randi made a standing offer on one million dollars to anyone who could demonstrate psychic powers. Nobody has yet succeeded.

• Scientist often make mistakes because: they are trained to believe what they observe; magicians and fakes are trained to create illusions and to deceive others.

• Duke University investigators after many years could not find anyone to demonstrate psychic powers upon demand and under controlled conditions.

• Research at Princeton University Anomalies Research (PEAR) conducted by engineers produced controversial results concerning persons being able to affect random events. Positive results were always very small: no more than a few parts per 10,000, on average. PEAR program closed in 2007 after 28 years.

• In 1988 the US Army asked the National Research Council to study ESP, aiming toward strategic advantages over others, including USSR, which was also studying such phenomena.

• Biofeedback connected to other instruments and actuators might eventually be used to move things. In such a way, Stephen Hawking, for instance, could control his wheelchair, talk (simulation) or write. Intel now has a project to help him.

• Chips are being implanted in the bran, which can pick up thought patters and activate some type of activities carried out via computer and actuators.

• One type of actuator could be superconducting magnetics that could make something levitate upon control of thought.

• REPLICATORS might one day be possible with nanotechnology. Already nature does this by taking food and making organisms, slowly in the case of larger objects.

• Eventually maybe nanobots, programmable atomic machines are `possible that can rearrange atoms within an object.

• There is already a technology for optical scanning an object, like a took, and the using composite material & binder material "print" the object layer by layer by laying down this material.

• Others envision using scanning probe microscopes (like the scanning tunneling microscope) to assemble objects atom by atom.

• Conclusion: Though Psychokinesis does not exist today, perhaps some semblance will be possible as we become more aware of thoughts in the brain using EEG, MRI and other methods. Within this century may be possible to move things by mentally controlled actuators. Much longer for detailed, atomic level replicators.

7: Robots

Someday in the next thirty years, very quietly one day we will cease to be the brightest things on Earth.

- JAMES McAlear

• Many (experts) believe that computer-like machines can ever obtain intelligence capability anything like the human bran, which is extremely complicated.

• First crude robot was made in 1738, an android that could play a flute; also a mechanical duck.

• Word "robot" conceived in 1920, Czech language for "labor"

• Although physics is quite advanced, the basic laws of intelligence are quite shrouded in mystery.

• Turning proved mathematically that there were true statements in mathematics that are incomputable, that is, forever the reach of computers, no matter how powerful.

• After Turning broke German code and tuned the tide of war, he was found to be gay, forced to take drugs, which gave him many problems, so committed suicide by eating a cyanide laced apple. Some think that Apple Computer logo is a tribute to him.

• "Turning Test": if one has a conversation with hidden humans and computers and can not tell the different, the computer has attained human intelligence; a convenient definition rather than philosophizing.

• Most human conversations use only a few hundred words, and are limited to a small variety of topics.

• Computers are good at syntax (manipulating its grammar; formal structure) but not semantics (what the word means, within context)

• Roger Penrose believes that like Gödel's incompleteness theorem which proved mathematics is incomplete, that machines can never duplicate the brain due to the Heisenberg uncertainty principle.)

• Others believe that we ARE machines, with wetware rather than dryware.

• When eventfully a computer could beat a chess champ, people realized that such pro's are not necessarily "deep thinkers" but have a very ell tuned algorithm.

• Computers know only what they have been programmed to know.

• So, rather than taking the top-down approach giving the computer thousands of rules of commons sense, patters etc.), and effort is being made bottom up (allowing the computer to grow as a child does, accumulating information; neural networks). This strategy is guiding probes on Mars as they explore the surface and accumulate information.

• The simple creature c. elegans has only 30 neurons, but 7,000 synapses, making then very complicated. Humans has billions of neurons---

• Commuters are good at things that are difficult for humans, such as complex computations, things that require great number of steps rapidly, but have great difficulty at thins humans find easy.

• Must somehow program in emotions, such as fear, for protection, and may other facets of existence.

• Marvin Minsky defines "consciousness" as a society of minds, not localized but spread out.

• Presently finding limitations of silicon based computers, and looking for new avenues, such as optical, DNA atomic, quantum----

• Perhaps can become dangerous if reach the stage of being "self-aware".

• Some think that one day our brains can be stored as data, and downloaded into machines, making us immortal.

• The idea of creating thinking machines that are at least as smart as animals and perhaps as smart as humans could become reality if we can overcome the collapse of Moore's law and the common sense problem, perhaps late in this century. Although the fundamental laws of AI are still being discovered, progress in this area is happening extremely fast and is promising. Given that I would classify robots and other thinking machines as Class I impossibility.

8: Extraterrestrials and UFOs

- Either we are alone in the universe, or we are not. Either thought is frightening.

- ARTHUR C. CLARKE

• As of the time of writing the book, over 250 planets had been documented orbiting other stars in space. This number as greatly grown since them wit the rapidly increasing technological capabilities to observe.

• People have long been fascinated with the possibilities, and many books and movies have explored this subject for a long time.

• Water is a universal solvent, so is most likely necessary on a planet for the formation and evolution of life. Water is plentiful in the universe.

• A critical experiment was that of Stanley Miller and Harold Urey, who showed that adding energy to a soup of organic (carbon based) molecules resulted in very basic amino acids, the basis for proteins, hinting at how life might evolve.

• Also necessary in addition to water and organic molecules are self-replicating molecules like DNA.

• In 1961 Cornel University Frank Drake wrote an equation that might estimate the number of planets in our galaxy that would produce life like that on Earth.

• Result is between 100 and 10,00 in Milky Way. Carl Sagan suggested millions would be a better number.

• The Search for Extraterrestrial Life (SETI) project began with a paper written in 1959, suggesting that we listen in the microwave radio region.

• 1,420 gigahertz was selected as the most promising, because associated with hydrogen; frequencies around tat range called the "watering hole).

• Since many groups and individuals have done then much work, with no positive results.

• Today five million of individuals contribute screen savers on their computer to help in calculations to decode signals, consuming over a billion dollars of electricity, at no cost to instruction conducting research.

• Also newly realized that not only is a "goldilocks zone" necessary for an Earth-like planet, but also a large planet like Jupiter is necessary to fling junk away from the inner planets, and protect them.

•Also now realize that out large Moon gives stability to rotation about axis would be unstable. Without this size axis could change radically, making life impossible.

• Further life on Earth was almost extinguished sever times by ice ages, and extreme volcanic activity. Life is much more precarious than originally thought.

• Also important are magnetic field, moderate rotation speed,

• Earth is at a safe distance from center of galaxy and extreme radiation from black hole center and ancient massive tars and super novae.

• Usually detect planets by wobble of star about center of mass.

• New satellites, like Kepler, are dedicated to hunting for planets by looking at shadows cast on stars by orbiting planets. By this method can search many starts and et more detailed information.

• Regarding nature of life and organisms it has been pointed out tat during the Cambrian explosion of organisms on Earth there was a sort of an arms race evolution derby with many new species compering, and nature putting force a huge variety of shapes, sizes, strategies, etc.

• Basics: some sort of vision to explore environment, some type of thumb for holding and manipulating, and some sort of communications, like speech.

• Someone hypothesized Type 0, I, II, III civilizations:

> 0: Like us still using fossil fuels and very little solar; also still tribal, religious.
>
> I: can harvest planetary power, all sun energy that arrives, power of volcanoes, manipulate weather, Control earthquakes, build cities on ocean.
>
> II: utilize entire power of sun, Immortal in the sense that nothing can destroy it; since can move to another planet
>
> III: Utilize power of galaxy. Like Borg in Star Trek.

• Perhaps aliens would ignore us, like we ignore ants. Can get resources from many planes without hassle of dealing with us.

• Regarding ancient aliens idea, and present day ones, many people believe, whether true or not. Repots of strange objects and lights in sky going back thousands of years.

• None has produced hard evidence that lead to reproducible results.

• Aliens could actually be nanotechnology.

• Or if base on he moon they could be small machines, like a jet aircraft.

• Yet many people understand just how small we are and how far away are other stars with the speed limit of light.

9: Starships

This foolish idea of shooting at the moon is an example of the absurd length to which vicious specialization carry scientists… the proposition appears to be basically impossible.

- A. W. BIKERTON, 1926

The finer part of mankind will, in all likelihood, never perish-they will migrate from sun to sun as they go out.

And so there is no end to life, to intellect and the perfection of humanity. Its progress is everlasting.

- KONSTATINE E. TSIOLKOVSKY, FATHER OF ROCKETRY

• One day our Sun will become a Red Gant, and Earthlings must leave.

• Carl Sagan has said that we should be a "two-plant species", just in case some disaster occurs here. Hat we a to precious and evolution to waste.

• The last ice age ended 10,000 years ago. When will be the next one? Or large meteors can crash into Earth. Last large one 65 million years ago. Our galaxy will eventually collide with Andromeda.

• Nearest star = 4 light years. With present-day technology would take 70,000 years.

• NASA's NSTAR "ion thruster" was tested in space in 1998 for 678 days. Just a glow of ions from a filament, compared to the blast of a rocket.

• A magneto-plasma engine is also possible, or nuclear fission.

• But no matter what type of engine is used, a staggering amount of fuel would be necessary.

• There are also "solar sails", of which some small experimental ones have already been deployed. Perhaps can build a huge battery of (impossibly powerful) lasers on the moon that can sent light to the sails. Theoretically, on paper, such a system could accelerate a ship to about half the speed of light after some years, which could reach a nearby star within a decade. Would need more lasers at t other end to get back to Earth.

• There is also the "ramjet fusion engine", which would scoop up hydrogen in space to be used as fuel. Would be heated enough to produce fusion. If it could maintain 1g acceleration could reach 77% speed of light. Scoop 160 kilometers in diameter. Reach the Pleiades cluster (400 light-years away) in 11 years, due to length contraction. But we do not have fusion reactors here on Earth, and the p,p reaction is uncertain. And how to create the high temperature!!!

• "Nuclear electric rocket". A nuclear fission reactor is used to heat gases that act as the thruster. Test systems have been very complicated and are failure prone.

• "Nuclear pulsed rockets". Create shock waves by mini nuclear bombs. Huge, heavy and dangerous.

• In order to get material to build ship into space would need something like a "space elevator". The first 160 kilometers takes the most energy. A cable from Earth surface to outer space would have centripetal force. Built from ground to space, or vise versa. Put the tension is cable is much to high, and no functional material now exists. Many other problems.

• Once into space can use the "slingshot effect" around a planet or later around a double neutron star to accelerate a vehicle to very high speeds. Get acceleration by the motion of the planet or star.

• "Electromagnet rail guns". But when the accelerated payload comes out of the accelerating tube, impact with the atmosphere is like hitting a brick wall. AND the g force would break all bones of the astronaut and kill him/her.

• Unmanned probes based on nanotechnology. Must be very fast so that fields cannot greatly deflect trajectory. Also vast number to guarantee some reach goal.

10: Antimatter and Anti-universe

The most exciting phrase to hear in science, the one that heralds new discoveries, in not "Eureka" (I found it), but "That's funny---"

- ISAAC ASIMOV

If the man doesn't believe as we do, we say he is a crank, and that settles it. I mean, nowadays, because now we can't burn him.

- MARK TWAIN

You can recognize a pioneer by the arrows in his back.

- BEVERLY RUBIK

• An atomic bomb would be only 1% as efficient at converting energy as an antimatter one. 100% would be converted; 50% as usable energy and 5% as undetectable neutrinos.

• The first such particle discovered was the anti-electron (a positron). Same as an electron mass, but with a positive charge.

• The first antiproton was produced in 1955 at the Berkley Bevatron.

• Theoretically it would be possible o make anti-atoms, with an antielectron in orbit around an anti-proton. Actually being done now in the lab.

• The preset cost of making antimatter in colliers is HUGE!!

• A controlled interaction of matter and antimatter could be theoretically used as a propulsion engine, but extremely difficult to obtain, and dangerous.

• Also it has been difficult to locate matter in outer space.

• Slight asymmetry at the time of big bang, and basically all have already annihilated each other and our part of the universe only has regular matter.

• Beams of antimatter have been detected near the center of our galaxy, based on a specific wavelength of gamma rays.

•Space probes now trying to detect other pockets of such matter.

• When and if the are found, there are already plans of how to capture them and make use in a propulsion system. But maybe necessary to wait until next century.

• Dirac considered tat anti-mater was really "bubble in the Dirac sea", the vacuum being filled up with negative electrons.

• Dirac also propose the "spin" of particles, such as electrons. One Cambridge psychologist has proposed that both Newton and Pauli were Asperger's

disease, like autism, due to the lack of social interactions or desire to speak to anyone.

• Does anti-gravity exist?

Part II: Class II Impossibilities

• "*Class II impossibilities*" are technologies that sit at the very edge of our understanding of the physical world. If they are possible at all they might be realized on the scale of millennia (thousands of years) to millions of years in the future.

11: Faster Than Light

It's quite conceivable that (life) will eventually spread through the galaxy and beyond. So life may not forever be an unimportant trace contaminant of the universe, even though it is now. In fact, I find it a rather appealing view.

-ASTRONOMER ROYAL SIR MARTIN REES

It is impossible to travel faster than the speed of light, and certainly not desirable, as one's hat keeps blowing off.

- WOODY ALLEN

• According to Einstein's Special Theory of Relativity the speed of light – C – is the speed limit of the universe.

• Before he derived this theory he contemplated the contradictions between Newtonian mechanics and Maxwell's equations. In Newtonian physics there is no speed limit, including that of light. From the Newtonian perspective there is nothing special about the speed of light.

• Also Einstein noted that light is always moving, and never stationary.

• You can never race along side a light beams, since it is always moving at C, relative to anything, completely non intuitive.

• And from a Newtonian perspective time and distance is the same everywhere.

• Completely different, the relativistic equations that Einstein derived indicated that length, time and mass change, depending on the observer.

• Today the supreme accuracy of GPS depends on including the equations of special relativity.

• EPR experiments show that a correspondence occurs between to particle formed in the same sate, but no information can be transmitted faster than the speed of light.

• Using the General Theory Of Relativity, the fabric of space can expand faster than the speed of light, like during inflation, since no information is transmitted. But stars cannot move faster than C relative to each other.

• Within the General Theory there is a possibility of Worm Holes.

• But would need Negative Mass r Negative Energy.

• Negative energy could only be found far from planets and stars in "empty space".

• Could perhaps be detected by looking form "lensing effects, where an image from a distant is bent around the invisible energy/matter, while producing more than one image of the object.

• Perhaps possible to ide a wave f stretching space within a bubble.

• Another possibility I Worm Holes.

• But to open up a worm hole of one meter diameter would need negative mass equivalent to the regular mass of Jupiter, a huge amount.

• Perhaps a Type III civilization could manage this, but for now thi is a Type II impossibility.

12: Time Travel

> If time travel is possible, then where are the tourists from the future?
>
> - STEPHEN HAWKING
>
> [Time travel] is against reason said the time traveler.
>
> - H. G. WELLS

• Time is one of the greatest mysteries of the universe.

• See the book for some historical considerations of time, and interesting/fun quotes.

• If we can move forward and backward in space, why not time?

• According to special relativity, time (a clock in system moving elative to an observer outside this system) slows down.

• Traveling to the past seems to be impossible, since we cannot go fasted than the speed of light, according to special relativity.

• So someone in a rocket ship moving at high sped, would be younger than those a the starting point when he returns, so in essence would have moved into the future-----(interestingly, the do not move into that future with their friends, but drop into it upon return)

• Hawking's statement about: why we have no visitors from the future, or past---- no time travelers---

• Hawking proposed: "Chronology Protection Conjuncture" to ban time travel from the laws of physics in order to "make history safe fir historians".

• Nobody could prove such a law, so Hawking stated: Time travel may be possible, but it is not practical".

• Kip Thorne sates: --- Because physicists have realized that the nature of time is too important an issue to be left solely in the hands of science fiction writers."

• In Einstein's theory in fact, we often encounter something called "closed time-like curves", which is a technical term for paths that allow for time travel into the past. If we followed the path of a closed time-like curve, we would set out on a journey and return before we left.

• The first time machine involves a "wormhole". In general relativity equations can connect two distant points in space. The same wormhole can also connect two points in time.

• Says Kaku-san, "because the laws of time travel are so closely linked to the physics of wormholes, time travel seems to qualify as a Class II impossibility."

• I feel very uncomfortable with Kaku's presentation of this chapter. He makes no god arguments for such a possibility, but wants to include this as within the realm of possibility. Doubtful------

13: Parallel Universes

- "But do you really mean, sir," said Peter, "that there could be other worlds-all over the place, just around the corner-like that?'
- "Nothing is more probable," said the professor…. While he muttered to himself, "I wonder what they do teach them at these schools."

C. S. LEWIS, THE LION, THE WITCH AND THE WARDROBE

- "listen: there's a hell of a good universe next door; let's go

E. E. CUMMINGS

• "Alternate universes enable us to explore the world of "what if" and it's delicious, intriguing possibilities.

• But such ideas have been around for thousands of years: the homes of the gods, or ghosts; heaven hell and purgatory; Nirvana and different states of consciousness. Hindu's have thousands of planes of existence.

• Says Kaku: "If higher dimensions do exist, many of the properties ascribed to gods might become possible." Could appear and disappear a will, or walk through walls.

• Three types of possible parallel universes discussed in scientific literature: hyperspace, or higher dimensions; the multi-universe; and quantum parallel universes.

• HYPERSPACE: We move about in 3 dimensions. But we see nothing disappearing into another dimension. So must be smaller than an atom. Aristotle talked about the three dimensions, and Ptolemy in 150 AD offered a proof that higher dimensions are impossible.

• Gauss used lanterns on mountaintops to detect extra dimensions; failed. His student, Riemann, wrote equations in higher dimensions, which were used decade's later by Einstein for relativity.

• Artists, musician, philosophers and painters then explored the idea of higher dimensions after Riemann's equations. Picasso's cubism. And Dali-----. Duchamp----. H. G. Well's "invisible Man" and others.

• However, no evidence has ever been found of higher dimensions.

• However, in 1919 physicist Theodor Kaluza wrote a paper hinting about higher dimensions. He added one more spatial dimension to Einstein's 4-dimesional space-time concept. If the 5th dimension is allowed to shrink the equations split into two sets: one Einstein's standard relativity, and the other Maxwell's equations of light.

• This formalism hinted to Einstein the possibility of uniting light and gravity.

• Suggests that "light ripples" in the 5th dimension. And this dimension must be "curled up". But size and how? Einstein played with idea until he died in 19555; after which people gave less and less attention.

• STRING THEORY: In the 1980s a huge confusing array of new particles discovered, making no sense until started to get grouped by symmetry into

Standard Model. (Fermi joked that to many names, like in botany, not "basic" physics.

• But "ugly" says Stephen Hawking since it contains at least 19 free parameters (including particle asses and strengths of interactions), 36 quarks and antiquarks, etc. etc. Also makes NO mention of GRAVITY.

• Tw main theories: QU and relativity, refereeing to different dimensions of space and force.

• No way found to blend these two major concepts.

• "Superstring theory" changed many things. That electrons, quarks and other basic particles are actually strings" vibrating in different modes.

• Einstein's theory emerges as just one of the lowest modes of a vibrating string.

• But they can only vibrate in 10 dimensions. If try other number of dimensions he theory breaks down.

• Since our universe s 4-dimensional, the other dimensions must collapse, like in the theory of Kaluza.

• If other than 4 dimensions the gravitational force should be other than $1/r^2$, but all measurements show this to be correct at forever-greater lengths.

• But need better measurements at ***shorter*** distances. All so far show $1/r^2$ is correct, and there 4-dimensional space.

• According to superstring theory, our normal view of the universe around us represents but the lowest vibrations of the superstrings.

• MULTIVERSE: Why are there five (5) different string theories to choose from? Witten proposed that all 5 are actually the same if we add et another dimension, to make the total 11. They "collapse" into one.

• In 11 dimension, a new entity appears, called a "membrane", or "brane".

• Thus all 5 theories were just different ways f moving a membrane down from eleven to ten dimensions. (page 238).

• Perhaps the universe itself is a membrane, floating in an 11-dimension space-time. So perhaps we live in a multiverse with other universes. Imagine many floating bubbles (membranes). Each bubble represents an entire universe floating in a larger arena of eleven-dimensional hyperspace.

• We are rapped in our universe, and cannot communicate with others, but gravity can interweave among them.

• Some believe that "dark matter" (which surrounds our galaxies) might actually be ordinary matter floating in a parallel universe. Dark matter would be the next higher vibrations of superstrings.

• QUANTUM THEORY: Although quantum mechanics is the must successful and accurate theory produced by physicists, it comes along with a number of paradoxes.

• Quantum mechanics gives only probabilities.

• And then there is Schrodinger's cat: in a sealed box the cat has to parts to its wave function: alive or dead; can only crash wave function to one of the possibilities by observation through human intelligence.

• But in fact, quantum mechanics really applies to only microscopic, atomic, molecular systems, since anything of larger size will have Decoherence-----

• Today engineers routinely manipulate atoms and particles, while in consideration of the uncertainty principle, which is a measure of accuracy.

• Some argue that it is impossible to formulate a satisfactory QM without considering consciousness, an even so far as saying hat this implies a cosmic consciousness, like gods---

• Also "many worlds" idea: universes split of for every possibility; one with Al Gore as president--- on absurdum---

• Steve Weinberg suggests that all the alternate possibilities have "decohered" except for the one we tuned in to. "---the "many worlds" idea is a "miserable idea, except for al the other ideas."

• QUANTUM UNIVERSES: Regarding "many worlds" interpretation of QM by Hugh Evrett, Bryce DeWitt, opposed it and said he can not feel himself split. Later became a strong advocate.

• John Wheeler said too much baggage-------

• BUT people wanted to find a way to apply QM to the universe, and this gave an IN, since multi wave functions of reality.

• An interesting point is that in the beginning, big bang, the universe was less than the size of an electron, and therefore very much in the QM domain. And if an electron can be in various states until observed, why not the universe too, so some say.

• BUT, how can an "outside observer" collapse the wave function of the universe?

• Perhaps many universes are born and die immediately as energy pops from and back into the vacuum.

• Hawking claims that "Our universe" has the highest probability in the multi-universe wave function, and therefore there is only a low probability that other universes can exist in the multiverse.

• That our universe came from a fluctuation of the vacuum is in a way testable in that there seems to be exactly the same amount of positive and negative charge in the universe. As is angular momentum. As is energy.

• CONTACTBETWEEN UNIVERSES? Kaku claims that impossible to contact decohered universes. As our universe comes to an end in the "Big Freeze", perhaps a class III civilization could concentrate enough energy on a spot to open up a wormhole in the vacuum of space. And start over again.

• A BABY UNIVERSE IN THE LABORATORY: Inflation theory solved many problems when trying to describe the big bang and subsequent events. Alan Guth says that in order to jump start inflation at the beginning of time there were tiny bubbles of space-time, one of which inflated enormously to become the universe of today. Inflation theory consistently seems to be the best idea for explaining the big bang and is consistent with all new data from satellite experiments and other. (see book----------)

• THE EVOLUTION OF UNIVERSES?: (see book---- to wild)

• Conclusion: Currently our technology is too primitive to reveal the presence of these parallel universes. So all tis would qualify as a Class II impossibility – impossible today, but not in violation with the laws of physics. On a scale of thousands to millions of years, these speculations could become the base of a new technology for a Type III civilization.

Part III: Class III Impossibilities

• "*Class III impossibilities*" are technologies that violate the known laws of physics. Actually few. If they turn out to be possible, major shifts in our understanding of physics must occur.

14: Perpetual Motion Machines

Theories have four stages of acceptance:

i. this s worthless nonsense;
ii. this is interesting, but perverse;
iii. this is true, but quite unimportant;
iv. I always said so.
- J. B. S. HALDANE, 1963

• Intro: see book------Always been people hoping for free energy---

• HISTORY VIEWED THROUGH ENERGY: 10,000 years ago after the end of the last ice age, humans domesticated animals, and for the first time had the ability to plow fields, travel quickly, carry much weight. Founding of the first cites. Artisans, architects, builders and scribes. Life expectancy jumped from 20 to 30 years---- Each person had one or two horsepower available.

• About 300 years ago came the next jump: steam engines; energy per person sored to tens of horsepower. Could now cross the continent in a few days; Towering cities. Plow giant fields rapidly. In 1900 average life expectancy became about 50 years. Each person as hundreds or thousands of horsepower. But rapidly need more with growing population and new technology----

• PERPETUAL MOTION MACHINES THROUGH HISTORY: Starting in about the 8th century in Bavaria the have been hundreds of proposals for perpetual machines, including some by Leonardo da Vinci , all eventually proved to be useless---

• HOAXES AND FRAUDS: Endless hoaxes and frauds, but all f tis stimulated science to better understand thermodynamics, eventually resulting to the three ways of thermodynamics:

• The total amount of matter and energy cannot be created or destroyed.

• The total amount of entropy (disorder) is always increasing; crudely speaking ha energy always flows from hotter to colder laces.

• You can never reach absolute zero.

Another ways of saying this:• You can't get something from nothing, • You can't break even; you can't even get out of the game.

• Boltzmann committed suicide after formulating these laws and receiving a lot of shit for doing so.

• LUDWIG BOLTZMAN AND ENTROPY: At this time, though Newton's laws were generally accepted. Many did not buy into the hypothesized idea of atoms. Boltzmann derived the laws of gases by assuming atoms (like billiard balls) acting under Newtonian laws. His idea, and similarly those of James Clerk Maxwell, led to the physics of statistical mechanics. Died on 1906, just a year after Einstein had written a paper proving the existence of atoms (??? effect)

• TOTAL ENTROPY ALWAYS INCREASES: The Second Law of Thermodynamics seems to be a deep truth of nature--------

• THE THREE LAWS AND SYMMETRIES: The result of some symmetry is a conservation law (idea discovered in 1918).

- if laws remain the same over time >>>> conservation of energy
- if laws remain the same in different directions >>>> momentum is conserved in these directions
- if laws remain the same under rotation >>>> conservation of angular momentum

• Before these ideas were cute, but today we realize that symmetries are the essential feature that define any theory. In creating new theories, we physicists first start with symmetry, and then build the theory around it.

• ENERGY FROM THE VACUUM? : The "nothing" of the vacuum is not empty, but teaming with activity.

• One proponent of this idea was Nikola Tesla: That the vacuum might contain vast amounts of energy. The "vacuum" would be the ultimate storehouse of energy. Was an assistant to Thomas Edison; and then a rival. Tesla founded C as opposed to Edison's DC.(over 700 inventions and patents). Perhaps first invented radio and X-rays. Also, a "zero point energy that can be extracted".

• Today we know that "dark energy" exists in the universe (73% of). In the pure vacuum, which is actually pushing galaxies away from each other. Dark energy even exists on Earth, but is too small for any practical use, discrediting Tesla's idea.

• But in fact nobody knows how to calculate the "energy of nothing", or where it came from.

• Perpetual machines are a Class III impossibility and "dark energy" is a deeply mysterious subject.

15: Precognition

- A paradox is truth standing on its head to attract attention.
NICHOLAS FALLETTA

• In all religions there are some aspects of prophecy and predicting the future.

• Kaku gives an interesting story about Cassandra: the Apollo was attracted to her beauty, and in pursuit of her gave the ability of prophecy. When she rejected him, he added that nobody world believe her. Even though she prophesized the demise of Troy, the Trojan horse, death of Agamemnon, etc., nobody believed, and all paid the consequences.

• Nostradamus in 16th century (and Edgar Cayce) claimed he could lift the veil of time. Some appear to have happened, but the original statements were so obscure as to allow more than one outcome.

• Many have predicted the end of Earth----, BUT------

• See the book about Seventh-day Adventist Church (14 million today) & Jehovah's Witnesses (6 million today). Splinter group: Branch Davidians (Waco, Texas).

• CAN WE SEE THE FUTURE?: All experiments have been negative, and (Newtonian) physics is based on "cause and effect".

• BACKWARDS IN TIME: But Maxwell's equations have two solutions: a "retarded" wave which represents moving into the future (radio waves, microwaves, TV, radar etc., etc.) and "advanced waves), which move from future to past. Success of former stimulated many to forget other solutions as only a mathematical curiosity, not reality.

• Some "mystics" would claim such "advanced waves" as being messages from the future. Perhaps we could send messages into the past, to alter the present--- for various reasons. Could send letter and messages of warning, etc.

• Richard Feynman played with going back in time, and using the Dirac equation found that an electron going backwards in time is the same as an antielectron going forwards in time. Thus, this behavior f an electron would allow the motion of antimatter. The electron-antielectron annihilation process was just the same electron deciding to go backwards in time. Antimatter is thus just ordinary matter going backwards in time. This explained the puzzle that all particles have their antiparticles---

• Thus all particles can go back in time, masquerading as antiparticles (equivalent to the "Dirac sea").

• Feynman's interpretation actually preserves cause and effect. By pursuing these ideas, Feynman eventually developed quantum electrodynamics, and won a Nobel prize.

• TACHYONS FROM THE FUTURE: Tachyons are particles that travel aster than the speed of light. Further, as they lose energy the move faster. Can be represented as "im".

• Might have existed in the early universe, and got the big bang banging, but no longer exist.

• If a dam exists, it is a "false vacuum" since if the dam breaks, water flows to a "true vacuum".

• With the presence of tachyons, there was a false vacuum; and the system was unstable. A tiny "rip" appeared in the fabric of space-time, representing the true vacuum. As the rip got larger a bubble emerged; Outside the bubbles the tachyons still exist, but not within. As the bubble expands, we find the universe, as we now know it, without tachyons. This is the big bang.

• And a tachyon, called "inflation", started the inflation process. (see book----)

• The Iggs boson started out as a tachyon, and eventually gave mass to all other particles. Thus precognition is a Cass III impossibility.

Epilogue:

There is nothing so big nor so crazy that one out of a million technological societies may not feel itself driven to do, provide it is physically possible

- FREEMAN DYSON

Destiny is not a matter of chance - it is a matter of choice. It is not a thing to be waited for-it is a thing to be achieved.

- WILLIAMS JENNINGS BRYAN

• **The Future of the Impossible**: Are there some things that will always be out of reach? Sometimes mathematics has absolute rules: such as the trisection of a triangle using only a ruler and a compass. Although thee are some things in mathematics that are absolutely impossible, we must be careful to say the same thing for the physical realm. Strangely, Albert A Michelson 1n 1894 sated that it will be impossible to discover any new physics. But then soon came relativity and quantum physics.

• The key point is that the "laws" of physics as we know them can change!!

• Amazingly famous philosopher Aguste Comte in 1825 stated:

1) The "Ultimate structure of bodies must always transcend our knowledge" We cannot know the true nature of matter.
2) Mathematics can never used to explain biology r chemistry.
3) It is impossible that studying heavenly bodies would have any impact on human affairs.

• DETECTING THE PRE-BIG BANG ERA:

• Maybe we can use neutrino radiation and gravity waves we will one day get a better look at times (1 second and 10^{-35} second, respectively)near to the big bang, just as the cosmic background radiation has gotten us o about 300,000 years after it.

• Historically, scientist like Galileo used visible light for exploration, and then radio waves to probe other regions, like the center of galaxies to find black holes.

• THE END OF THE UNIERSE:

• Present cosmology suggests that "dark energy" is pushing the galaxies apart and that the end of the universe in trillions of ears will be the "big cold when everything runs down to near absolute zero. But can this scenario change in the future? Is the universe bound to follow our present interpretation? Need to understand the "cosmological constant" and/or the "energy of the vacuum." Is the "constant" really constant----?

• Newton and later others had to confront the question: if attracting gravity connects the entire universe, why does it not collapse. Einstein got around this by the "universal constant" which in essence stipulates energy of the vacuum that maintains the universe---- Then Hubble found and expanding universe and Einstein was embarrassed with his constant and retraced it. Now people think that the universal constant is the major energy, 73% (vacuum), source of the universe.

• A THEORY OF EVERYTHING?

• Major candidate is string theory. Many have caught the bug to attempt this challenge, but all have failed, so far----

• CRITICISM OF STRING THEORY:

- Many!! And too much talent trying-------

• IS STRING THEORY UNTESTABLE?

- History has shown that there indirect ways to observe phenomena that are believed not be directly observable.

• IS PHYSICS INCOMPLETE?

- Ahhhhhhhhhhhhhhhhhhhh