Kepler –62e and –186f: Face the Alien

The Cataclysmic Event of Our First Encounter with Intelligent Extraterrestrial Beings

By Robert M L Baker, Jr.

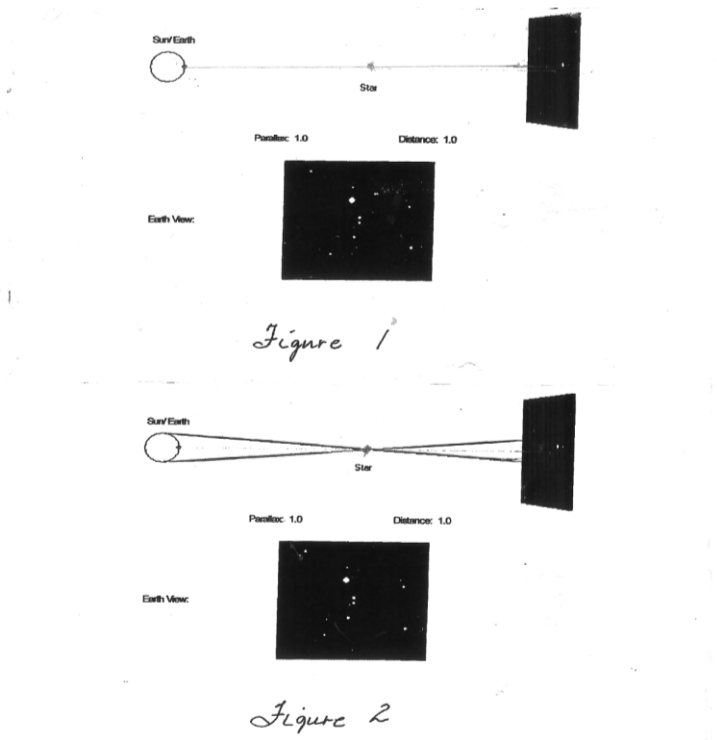
ABSTRACT

A survey is made of the current status of the search for Exoplanets by NASA's Kepler satellite. How the Kepler satellite and other Exoplanet finders function is discussed. Estimates of those Exoplanets in the "habitable zone", which might serve as cradles for the development of extraterrestrial intelligent beings, indicate that there might be as many as one hundred sextillion! One can be concerned that civilizations self destruct (*Fermi's Paradox*) and this concept is analyzed using very approximate and arbitrary numbers. It is concluded that there might remain at least about 420,000 possible Worlds intercommunicating with high-frequency gravitational waves (HFGWs) at any one time in any one region of our Universe, such as our Solar System's region, before they might self destruct or otherwise be eliminated. We predict the form of such beings by an imaginary projection of the evolution of "Earthling" homosapiens to become "cyborgs." We then propose that such cyborg forms of intelligent beings would be encountered by us. The first cataclysmic encounter with them is expected to be by eavesdropping or interception of their interstellar communications. It is argued that such advanced beings would utilize direct mind-to-mind or brain-to-brain communication and the most reasonable medium for interstellar communication would be by means of HFGWs and not electromagnetic radiation. Some six such HFGW detectors or receivers are presented.

1. Introduction and Literature Survey of Exoplanets

Johannes Kepler was born on December 27, 1571, at the Free Imperial City of Weil der Stadt (now part of the Stuttgart Region , 30 km west of Stuttgart's center) and was a famous German mathematician, astronomer, and astrologer. A key figure in the 17th century scientific revolution, he is best known for his laws of planetary motion. These laws were the result of extensive telescopic observations of the planets as an assistant to the famous observational astronomer **Tycho Brahe**. His works also provided the foundations for **Sir Isaac Newton**'s theory of universal gravitation. Quite fittingly the NASA satellite launched in 2009 that is searching our Universe for other habitable planets is named after him. Kepler and others at the time realized that the Sun is a star and that the

planets traveled around it. It is only natural then, to suspect that other stars had planets of their own and that some of these might be habitable and able to support intelligent life forms. 61 Cygni is the first star other than the Sun to have its distance from Earth measured. The star's large angular motion relative to the other stars (termed proper motion) allowed for triangulation or surveying to determine its distance. In the 1960s it was thought that this nearby star (about nine light years away) had a planet on orbit around it – but it was later proved planetless.



Slide 2

Conformation of such "Exoplanets," came in the early 1990s, when astronomers found compelling signs of smaller bodies orbiting stars. These signs included the wobble of a star caused by orbiting planets. As of 2013 (*Science* **340**, pp. 565-581) *it was estimated that our Galaxy (and there are 100 to 200 billion galaxies in our Universe) contains at least as many planets as stars and there are 200 to 500 billion stars per galaxy!* Thus there may be as many as about 200,000,000,000X500,000,000,000 = 100,000,000,000,000,000,000,000 (= 10^{23} or one followed by 23 zeros or **one hundred sextillion**) Exoplanets out there!

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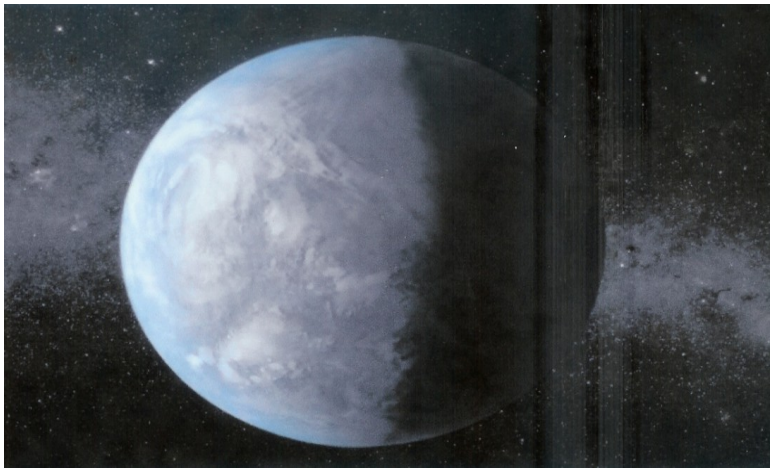
In the last few years many orbiting planets or Exoplanets in the neighborhood of our Galaxy have been detected and a few thousand others were under investigation in 2014 (Brent Ellerbroek, *Nature* **512,** pp. 144-145). The preponderance of evidence suggests that there are hundreds and probably millions or billions of such habitable planets in our neighborhood of the Universe. For example, Gliese 832 is an Exoplanet in the habitable zone larger than the Earth, but smaller than Neptune. It was detected in August of 2014 (*Astrophysics Journal* **114,** p. 791). In September of 2014 water clouds were detected around a brown dwarf star some 7.3 light years away from our Solar System – the first such sighting of water beyond our Solar System (S*cience* **345**, p. 1103). Also last September the first signs of water were seen in the atmosphere of a Neptune-sized planet, paving the way towards the search for water on smaller Earth-sized Exoplanets (Jonathan Fraine, et al. , *Nature* **513**, pp. 526- 529) . The most commonly observed class of planetary system so far consists of one or more planets one to three times the size of the Earth, orbiting much closer to their star than the Earth does relative to the Sun. Although it is not possible to predict the exact characteristics of alien life forms (later in this talk I will attempt to

do so) it seems reasonable to assume that they would flourish in a temperature range the between freezing and boiling points of water. In May of 2013 **William J. Borucki** and a host of other scientists detected a five-planet system called Kepler-62 (a designation identification number for planetary systems observed by NASA's Kepler satellite observatory; William J. Borucki, *Science* **340,** pp. 587-340) the outermost of the five planets, termed Kepler-62e and -62f are in the aforementioned habitable temperature zone respectively receiving 120% (1.2 ± 0.2 times) and 41% (0.41 ± 0.05 times) of the solar flux at the Earth's distance from our Sun.

Theoretical models of Kepler-62e and -62f "… for a stellar age of about 7 billion years suggests that both planets could be solid, … with a rocky composition ..." The artist's concept depicts the more likely host of the two, Kepler-62e, a super-Earth-size planet in the habitable zone smaller and cooler than our Sun, located about 1,200 light-years from Earth in the constellation Lyra.



Slide 4, Artist's depiction of Kepler-62e

(*Nature* **497,** p. 417 and NASA Website)

Kepler-62e orbits its host star every 122 days and is roughly 60 percent larger than Earth in size. Scientists do not know if Kepler-62e is a water-world or if it has a solid surface, but its discovery signals another step closer to finding a world similar to Earth. In August of 2014 a super-Earth planet was detected in the habitable zone of a star called Gliese 832. Its mass was about 5.4 Earth's mass and the scientists believed that the Gliese system was "… a rare miniature version of our Solar System …" (Robert Wittenmyer, *Astrophysics Journal,* **114,** 791). Atmospheric studies are the next step towards developing a comprehensive understanding of the new class of objects. Much effort has been focused on using transmission spectroscopy to characterize the atmospheres of these super Earths, but previous

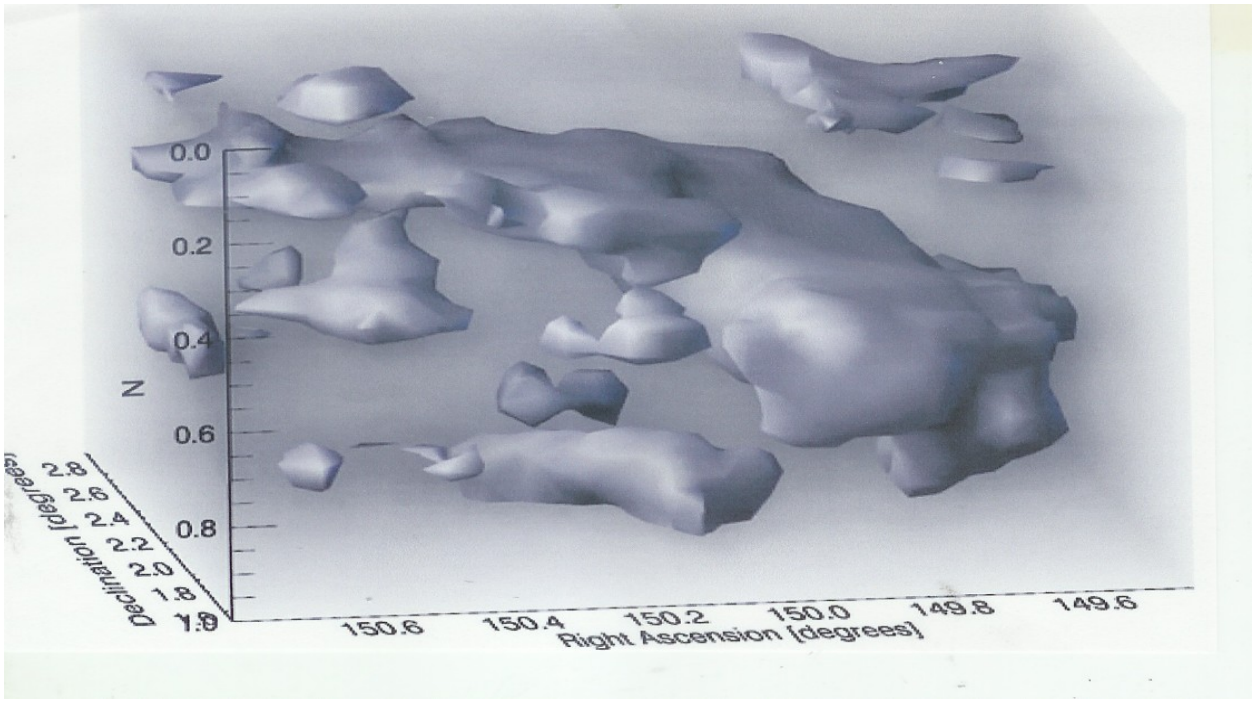
observations did not have sufficient precision to distinguish between different atmospheric compositions. Many observers are confident that more precise observations will reveal that these Exoplanets must contain water or methane clouds to be consistent with the data.

As we have discussed, people have pondered the existence of Earth–like Worlds beyond our Solar System for millennia. A number of excellent recent (2014) survey papers can be found in the Special Section of *Science* **340,** pp. 565-581 and in *Nature* Insights, **513**, pp. 327-366. In 1997 Borucki and his colleagues, using a land-based observatory mock up of the Kepler satellite, were successful in monitoring the brightness of some 6000 stars simultaneously. Thus the concept of the Kepler satellite was proven and its program resulted in its launch in 2009.

Slide 5, Kepler Satellite Observatory

In four years after its launch Kepler had monitored the brightness of some 150,000 stars and it has discovered more than 2,700 possible Exoplanets. It is now estimated that there is "… at least one planet for every solar-type star" (Alexis Brandeker, *Science* **343,** p. 1440). By 2013, follow-up observations by ground – based telescopes had confirmed 122 Exoplanets. Roughly half of these candidates are estimated to be twice the size of the Earth or smaller -- many of these could be rocky planets. *The findings suggest that hordes of earthlike planets exist in the habitable zones of stars and are waiting to be discovered*! In today's findings the habitable zone (sometimes referred to as "Goldilocks Zone") of a star is defined as "the annulus around the star, where a rocky planet with a carbon dioxide$_2$ water and Nitrogen atmosphere, has sufficiently large water content (such as the Earth) so that it can host liquid water on its surface." Thus the temperature would need to be between the freezing point

and the boiling point of water. However the habitability zone must be considered on a case-by-case basis rather than that one-size-fits-all definition using water as the only possibility. Also there might be Silicon-based rather than Carbon-based living creatures (Silicon and Carbon have similar chemical properties), might exist in a Hydrogen-rich rather than an oxygen-rich atmosphere and other qualities that might support the development of intelligent beings. We should not rule out any possible life form. In fact consciousness or intelligence might exist within stars or within any structure, even within dark matter in the Universe! But for such "intelligence" to matter the ability to communicate is essential.

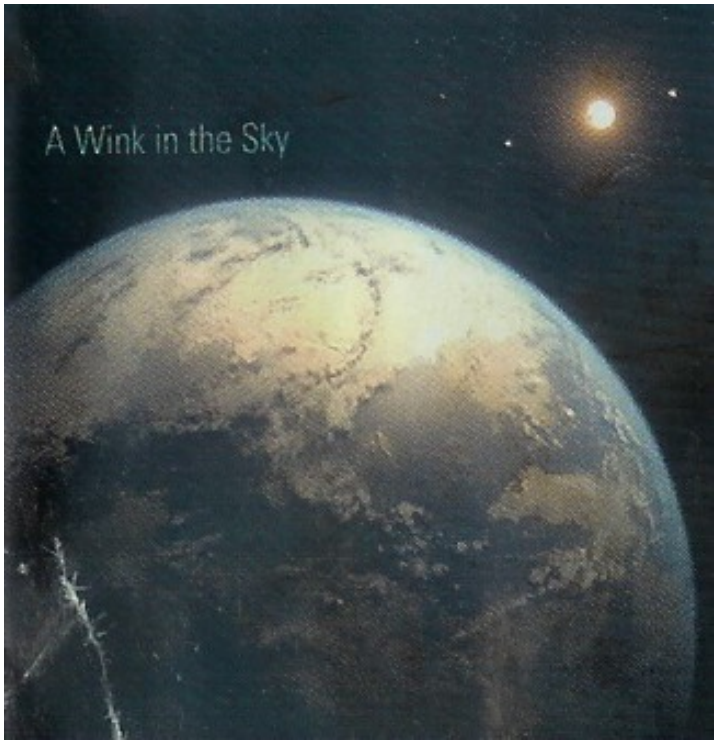


Slide 6, Dark Matter

Every month, the orbiting Kepler satellite telescope alone observes hundreds of new potential habitable Exoplanets in a patch of sky near the constellation Cygnus. Just last July (2014) the Exoplanet Kepler-93b was discovered having a planetary radius 1.48 that of the Earth and a planetary mass roughly 50% larger than Earth (Sarah Ballard, et al. *Astrophysics Journal* **790,** p.2). This corresponds to a rocky planet of density about 6 grams per cubic centimeter (for comparison, water has a density of one gram per cubic centimeter) and Kepler-93b may possibly be habitable!

In addition to Kepler-62e and 62f the quest for Earth- like planets continues. In April of last year (2014) scientists publish the detection of Kepler- 186f (Elisa V. Quintana, et al., *Science* **344,** pp. 277-280) a 1.11± 0.14 Earth-radius planet that is the outermost of five planets, all roughly Earth size, which is

about 500 light years from Earth. However this star is a red dwarf and is unlike our Sun. On the other hand, the intensity and spectrum of the star's radiation place Kepler-186f in the habitable zone, implying that Kepler-186f has an earthlike atmosphere and that water at its surface is likely to be in a liquid form.



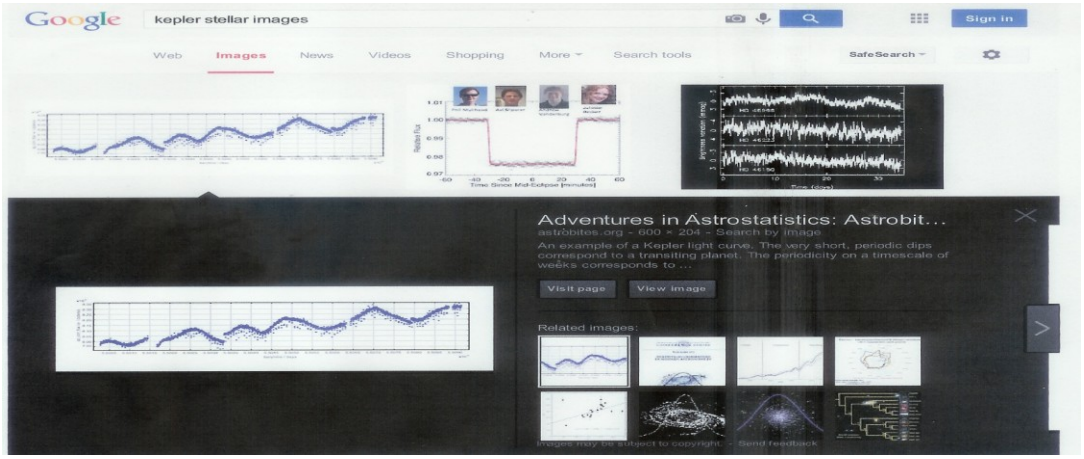
Slide 7, Artist's depiction of Kepler-186f

(Science 344, pp. 249-277)

2. How are Exoplanets Discovered?

Now let's discuss how, exactly, does Kepler discover Exoplanets? We need first to establish how an Exoplanet on orbit around a star would affect a telescopic image of the star. Of course if the telescopic image were highly resolved, then the Exoplanet itself could be "seen." In this case it would be a simple matter to identify Exoplanets. Unfortunately, almost all stars are much too far away for such actual images of their Exoplanet(s) to be resolved even if they were larger than the Solar System's largest planet, Jupiter. As an Exoplanet circles its sun or star, it causes that sun to wobble slightly, just as our Solar System's planets cause our Sun to wobble. But only very massive planets such as Jupiter produce a wobble large enough to be observed at rather short interstellar distances. Therefore only stars nearby our Sun can be seen to have a wobble large enough to reveal an Exoplanet companion. Such observations are called astrometry. **William J. Borucki**, the architect and principal investigator of

NASA's Exoplanet search mission Kepler wanted to utilize a different idea (Yudhijit Bhattacharjee, *Science* **340,** pp. 542-545). His idea was to measure the dip in light of a star when a planet passes in front of it between the star and the Earth. In order to measure Earth–sized planets he proposed monitoring thousands of stars simultaneously from a satellite on orbit above the Earth's atmosphere. He recognized that the natural variability star's brightness would limit researchers' ability to pick out the change in brightness caused by a transit, unless more advanced photometers were developed. He predicted that measurement of a 1% dip in brightness was needed to detect a Jupiter–sized planet around a Sun-like star whereas a 0.01% dip was necessary to detect an Earth–size planet. However the use of a charge coupled device (CCD) could simultaneously measure the light reduction caused by transiting planets for thousands of stars simultaneously. Such CCD's were capable at working at a level of precision required to measure a 0.01% dip in brightness. A CCD involves millions of very small photocells or pixels spread out in an array; say 10,000 pixels by 10,000 pixels square located in the focal plane or telescope image of a patch of sky such as might be observed by the Kepler satellite. NASA's Kepler spacecraft is not only the most prolific Exoplanet detector ever; it is a marvel of engineering. It's 1.4 meter diameter mirror funnels starlight to a 95 – megapixel camera (95,000, 000 pixels) capable of discerning dips in brightness as small as 10 parts per million mini–eclipses caused by an Exoplanet crossing a star's face. Therefore Exoplanets are detected as transit's that caused the whole star to appear periodically fainter when the planet passes in front of it along the observer's line of sight. Kepler-62 is one of about 170,000 stars observed by the Kepler spacecraft (William J. Borucki, et al., *Science* **340**, pp. 587-590). On the basis of an analysis of long photometric observations from Kepler taken during the period 13 May 2009 through 28 March 2012, they reported the detection of five planets orbiting Kepler– 62. Analysis of high resolution spectra indicates that Kepler – 62 is a solar-type star with the estimated mass and radius 70% of that of Earth. **William J. Borucki** and his associates computed the radius, semimajor axis, and radiative equilibrium temperature of each planet on the basis of light curve modeling given the foregoing stellar parameters.



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The masses of the planets could not be directly determined using radio velocity measurements of the host star because of the planets' low mass and natural variability of the star's brightness and the level of instrument noise. In the absence of a detected signal they statistically validated the planetary nature of Kepler–62b through Kepler– 62f .

To determine whether a planet is in the habitable zone he and his NASA associates calculated the flux of stellar radiation that each planet intercepts. It is convenient to express intercepted flux in units of the average solar flux intercepted by our Earth. Again the habitable zone is defined as the annulus around a star where a rocky planet with a carbon dioxide, water and nitrogen atmosphere and sufficiently large water content (such as on Earth) that can host liquid water on a solid surface.

But the Kepler satellite is not the only planet hunter. Recently on two mountain tops in Chile, two state-of-the-art instruments start scanning the skies for planets around other stars next year (Daniel Clery, *Science* **343,** p.833). The vast majority of the over 1000 Exoplanets National Laboratory identified so far have been found using indirect methods because the starlight wipes out their faint optical signals. But the new instruments, one North American and one European, *will see planets directly*! Fixed to two of the world's biggest telescopes, they push optical technology to the limit. "After 10 years building it, to see it view the sky is fantastic," says Bruce Macintosh of the Lawrence Livermore in California, principal investigator for the planet imager. The telescopes have been built by a consortium of US and Canadian institutions. Amateurs also search for Exoplanets. They report on their *Planet Hunters* website and have found a new Exoplanet: PH3c; which has a substantial atmosphere of hydrogen and helium gas (*Nature* **515**, p.167).

3. What Might be the Form and Capabilities of an Extraterrestrial Intelligent Being?

OK, so those hundred sextillion or 100,000,000,000,000,000,000,000 Exoplanets come into existence quite naturally in most star and possibly multiple-star systems. But how about the creation of "life" on some of those Exoplanets that are in the habitable zone or rather in a zone that we believe is a habitable zone of their star (or double star)? We have found that there is a high probability that there exist huge numbers of potential "Cradles of Extraterrestrial Intelligent Beings" out there. But how will we encounter them and what will we do when we do encounter them?

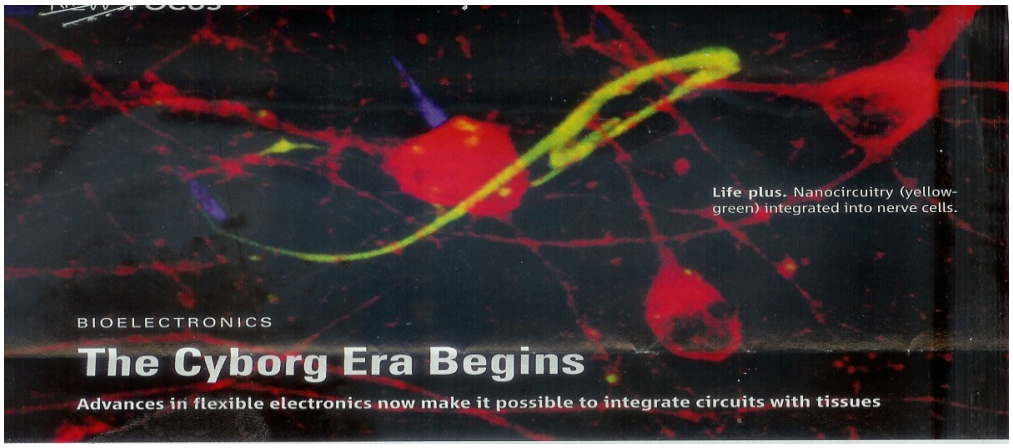
So far scientists have been unable to actually "create life from scratch" as it were. David Deamer (*Nature* **514**, pp. 302- 303) suggests that deep-sea hydrothermal vents may have provided the condition for the origins of life – the "first spark".

Slide 9, Deep-sea hydrothermal vents

Nature **514**, p. 302.

But that is not the crucial question. What we really would like to know is how life forms **evolve** on these far worlds and even more importantly what would be their form for those that might be far

more advanced than we earthlings. Since we have only one example of an intelligent life form, our own, we can only project how our humankind might evolve. We then could at least guess that advanced intelligent civilizations on one or more Exoplanets might have a similar evolution as on Earth. It seems likely, as will be discussed, earthlings will probably evolve into a blend of biological and electronic creatures, that is into *cyborgs*! The beginnings of a cyborg world have already arrived! (Robert F. Service, *Science* **340,** pp. 1162- 1165).

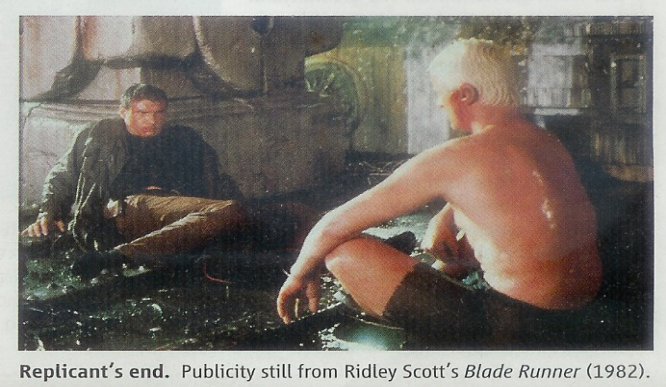


Slide 10, Science 340, p. 1162

Bioelectronic flexible circuits now make possible to integrate circuits with living tissues. There are also senses of "feeling." Localized pressure and temperature sensations give a sense of "touch." One of the most sophisticated devices to include sensory feedback is a prosthetic arm developed by researchers the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. Built as part of a US Department of Defense research program that has spent $ 144 million since 2006 to improve prosthetics for injured solders returning from Iraq and Afghanistan, the arm is equipped with more than 100 sensors that detect sensation ranging from temperature to pressure (Roberta Kwok, *Nature* **497**, p. 178). Technologies have been developed for artificial arms that give people finer and finer control over artificial limbs than ever before (*Sci. Transl. Med*. **6**, 257ra138; 257re6, 2014). The truly remarkable advances in such robotics were recently summarized by Richard Stone and Marc Lavine in a Special Section on "Robots" (*Science* **346**, pp. 179- 203).

But is this the way in which humanity will evolve? Christof Koch in his review of "How to create a Mind" (by Ray Kurzweil, Viking Press, 2012), states "Science-fiction novels and films have long

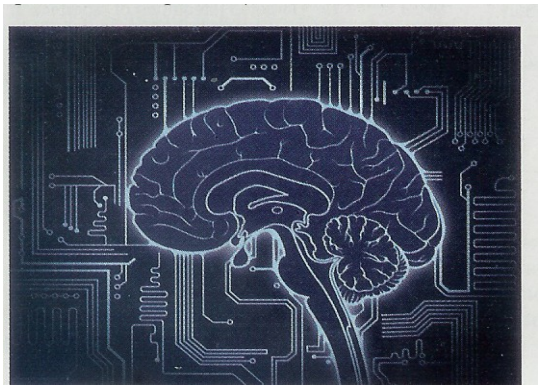
popularized the notion that machines will, sooner or later, match and ultimately exceed human-level intelligence. On the way they will acquire feelings and coconsciousness. In the movie *Blade Runner,,* a replicant exclaims in the face of his imminent demise 'I've seen things you people wouldn't believe …' ". (*Science* **339**, pp. 759-760). He further pooh poohs the idea that "…that biological limitations, including aging and insufficient memory and intelligence, should, and will be transcended by nanotechnology and artificial intelligence (AI)." (Termed "Transhumanism"). I agree with Koch, it will never be a pure machine it will be - a combination or blend of biological and electronic elements acting together; essentially the cyborg that Robert Service suggests. The biological elements will allow for art, invention, humor, emotion, etc. and the electronic elements will provide enhanced functions such as memory, logic, physical capability, computation, etc.



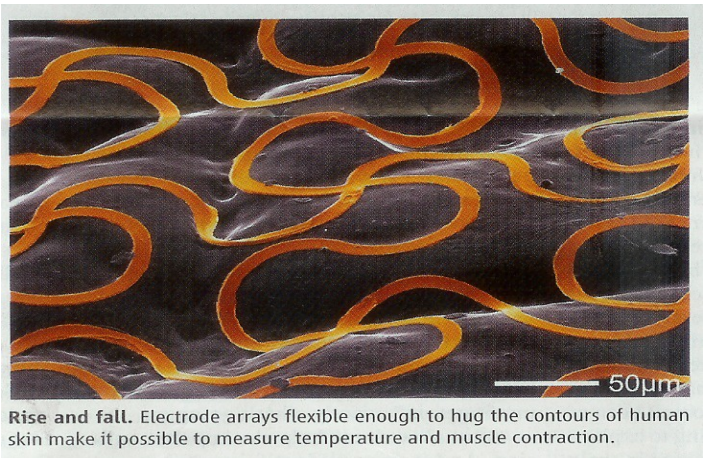
Replicant's end. Publicity still from Ridley Scott's *Blade Runner* (1982).

Slide 11, *Science* **339**, pp. 759

Such a combination or cyborg might evolve from a deep – brain stimulation (DBS) device. A DBS device not only delivers electrical pulses, but also records brain activity simultaneously, as been implanted in a person for the first time (*Nature* **500,** p.258). Until recently, there has been a lack of data on how the brain responds to stimulation that is used to treat motor disorders such as Parkinson's disease, and is being tested for some psychiatric conditions. Although exceedingly complex the human brain could be the "central cyborg." That is its essential organ of a cyborg as Christian K. Machens might propose along with his ideas in "Building the Human Brain" (*Science* **338**, pp. 1156- 1157).



Slide 12, Christian K. Machens, "Building the Human Brain," *Science* **338**, p. 1156



Rise and fall. Electrode arrays flexible enough to hug the contours of human skin make it possible to measure temperature and muscle contraction.

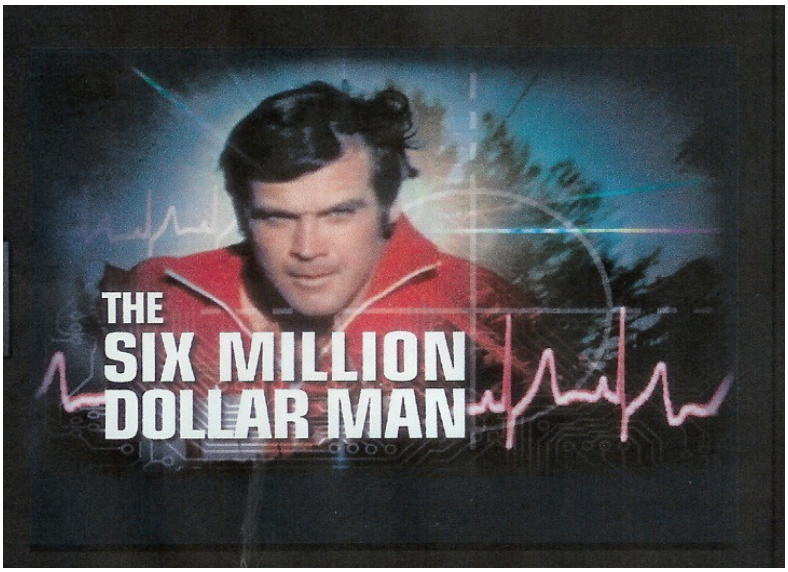
Slide 13, *Science* **349,** p. 1162

The humanoid Cylons in *Battlestar Galactica* or the Borg in *Star Trek,* who claim that resistance to incorporation into their collective is futile, are fictional projections of homosapiens' evolution. Nevertheless, research progress is real, as a mix of biologist, materials scientist, and nanotechnology experts are chipping away at a host of challenges." I see it as building a seamless interface between cells, tissues, and electronics," says Aleksandr Noy, a bio-nano-electronics expert at Lawrence Livermore National Laboratory and the University of California, Merced. (Robert R. Service, *Science* **340,** 1162-1165) For now, most of these efforts focused on providing better health care and quality of life for patients. But over time, expect devices "… that will make us better athletes and soldiers," or even reduce our facial wrinkles! Remember the Electrolift® mask device previously discussed!

"A few years ago these things were science-fiction. But now we are seeing the emergence of real devices and applications," Noy says. And fast, says Zhenan Bao, and organic electronics expert at Stanford University in California: "The competition is furious." (Robert R. Service, *Science* **340,** 1162-1165) The idea of fusing man and machine has long tantalized humanity. Over the past century, Rogers points out, researchers have pioneered myriad efforts to use electronics to measure biological activity and sometimes even alter it. They tailored metal electrodes that could be taped to the skin for use in electrocardiograms. They devised brain stimulator's that can be inserted deep within brain tissues to disrupt the neural firing patterns that cause debilitating tremors in patients with Parkinson's disease. And they created cochlear implants capable of converting sound to electrical impulses that can be registered by the inner ear. The Howard House Ear Institute here in Los Angeles has experts in this area. Furthermore the answer to Alzheimer's disease may be the insertion of memory microchips in a patient's brain to augment, improve or replace inoperative memory material there. As a matter of fact, just last summer (2014), Geoffrey Ling a top biotechnology research official at the Defense Advanced Project Agency challenged neuroscientists to do something extraordinary: "Develop an implantable device in a human brain that can reverse memory loss…" (Emily Underwood, *Science* **345**, p. 250) Also UCLA's Brain Institute and other universities are developing electronic prostheses that interact with brain regions critical to memory. Michael McAlpine, a mechanical engineer at Princeton University, and colleagues reported in the May 1, 2013 issue of *Nano Letters* (Manu S. Mannoor, et al. *Nano Letters* **13,** pp. 2634-2639) that they've made the first 3D printed functional organ: a bionic ear that "hears" acoustic sounds and ultrasounds. "We're trying to see if one could introduce augmented functionality that a human wouldn't ordinarily have…" McAlpine says.

Slide 14, **Engineering a Functional Ear** (*Science* **340,** p. 1165)

Three-dimensional (3D) printers work by using computer-driven laser printer to build up layers of material based inks, usually made from plastic. McAlpine's team started with three different inks: one made from silicone; another with silicone infused with silver nano-particles; and a third with chondrocytes, cells that produce cartilage, along with the gel to promote their growth. Numerous groups have used 3-D printing to make tissues, but they have typically printed only scaffolding materials and cells. McAlpine's team added a level of sophistication to the technology. The researchers printed out a metal coil in the center of an engineered ear that serves as an antenna capable of picking up acoustical signals and converting them into electrical pulses for the inner ear á la a conventional cochlear implant. Attempts to develop electronic organ function led to the development of bioelectric batteries (Bernd Fritzsch, *Science* **345,** pp. 631-632). Artificial electronic organs will function with organic batteries and drive implanted devices such as cochlear implants (M. A. Karami, D. J. Inman, *Applied Physics Letters* **100,** p. 042901) or pacemakers (M. Hansen, et al. *Otol. Neuotol.* **34**, p. 1681). It might even be possible today to turn nonfunctional muscles into electronic organs, thus generating enough bioelectric energy to drive small electric motors in already existing exoskeletons for human performance augmentation (Homayoon Kazerooni, pp. 773-792 of http://202.120.43.103/downloads2/7b95dd28-743a-488f-9e22-68ab47b60dee.pdf). Think "Six Million Dollar Man"!



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Then there is the "Brain Chip". A computer called TrueNorth accomplishes pattern recognition -- a major function of our brain. TrueNorth contains 5.4 billion transistors wired together to form an array

of 1 billion digital "neurons" that talk to each other via 256 million "synapses" the intercommunication media of the brain." It gets almost everything right," says Dharmendra Modha, an electrical and computer science engineer who leads the artificial brain project at IBM's Almaden Research Center in the hills beyond Silicon Valley (Dharmendra Modha, et al., *Science* **345**, p. 668).

Another macroscopic project is electronic skin, complete with tactile, temperature, and even chemical sensors. (Roberta Kwok, *Nature* **497,** pp. 176-178) Such skin could potentially be integrated into prosthetic limbs enabling users to feel and touch their world again, and perhaps get robots a new sense of their surroundings.

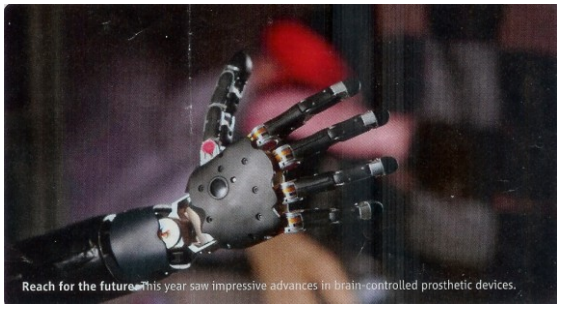
For electronics to work it must be soft flexible stretchable much like our own and that rules out conventional computer electronics made from rigid glass and ceramic chips. But flexible circuits are available now. (Robert F. Service, *Science* **340,** pp. 1162-1165) Probably an advanced cyborg entity would be designed to look like its original all-biological predecessor in order to be esthetically pleasing and friendly looking. Thus artificial skin would no doubt cover up the electronics in their Cyborgs --- much like the Cyborg or Android Bishop in the movie "Alien".

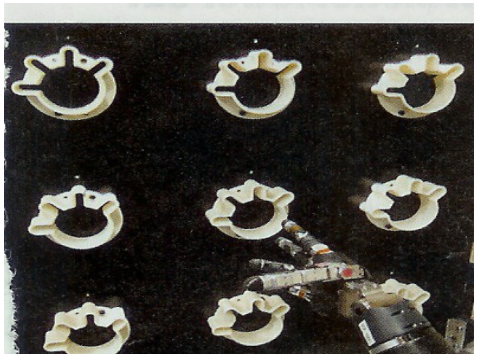
Slide 16, The Cyborg or Android Bishop in the movie "Alien"

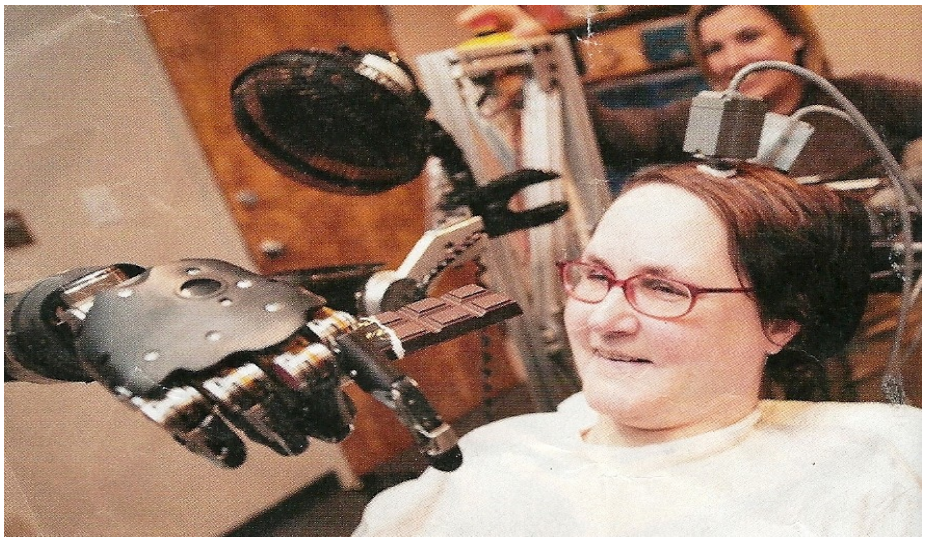
Perhaps the boldest direction in bioelectronics is the emerging effort of marrying tissue and electronics at the cellular level. And Harvard University, chemist Charles Lieber and his colleagues have

spent much of the last two decades pioneering efforts to grow ultrathin nanowires from the atomic scale up and to design them to work as transistors and other electronic devices. (Charles Lieber, *Harvard gazette* August 26, 2012) Nanoscale devices are the right size to monitor and influence biology inside cells. "It's really the natural length scale for electronic interface," Lieber says. (Robert F. Service *Science* **340,** p.1165) Ion channels in neurons are less than 10 nanometers in width, synaptic connections between nerves are less than 100 nanometers across, and neurons themselves are on the order of a micrometer. Devices at those scales could be revolutionary! Perhaps even more revolutionary are programmable electronic on-chip DNA compartments as artificial cells (Eyal Karzbrun, et al. *Science* **345,** p. 829).Thus it may be possible to build up parts of living, intelligent entities from their fundamental cells on up!

Finally, there is the brain-machine interface or BMI. Back in 2011 researchers described a prosthetic system that provides tactile feedback by stimulating the somatosensory cortex, the brain region responsible for the perception of touch (*Science* **338**, pp. 1530-1531). Andrew Schwartz at the University of Pittsburg in Pennsylvania and his colleagues implanted two microelectrodes in a woman's motor cortex, the part of the brain responsible for initiating movement. The devices recorded cortical activity associated with her desire to move a robotic arm. An external decoder connected to the electrodes and the arm converted these signals into electronic instructions for the artificial limb. Within 13 weeks she could grasp and move objects almost as fast, smoothly and accurately as an able-bodied person! (*Nature* **493**, p. 137).







Slide 17, *Nature* **515**, p.476

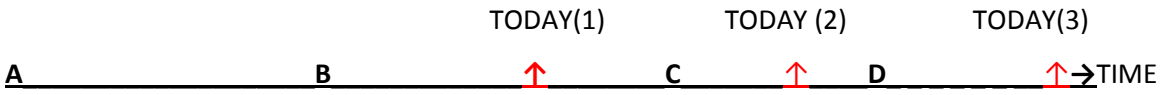
Also there may be no need for food as we know it. A skin composed of solar cells might provide the cyborgs' energy like the nano-tube fabrics studied by Pan, et al. (*Angew. Chem. Int. Ed.* **53**, 10.1002/anie. 201402561) and "stretchy batteries" woven with the composite skin (*Nature* **510,** p. 314) to store the energy during times of no illumination..

If mankind evolves into a cyborg entity, then it will be due to the aforementioned technological advances; many of which have already been made. Furthermore, such entities could well be repairable and include technological improvements in their "parts" as time goes by. They will evolve into ever improving creatures somewhat like the voluminous cathode-ray, Black & White TVs of the 1950s evolved into the color, flat-screen TVs of today. Therefore cyborgs could be immortal and constantly improving – that is until, as we will discuss, they may somehow eliminate themselves!

4. How soon will we discover Alien Life?

In order to answer this question it is important not only to predict how these cyborg-stage, interstellar-communicating, civilized-entities may function, but also to reexamine how many "life-supporting" Exoplanets are out there. Although these "Cyborg Civilizations" may be composed of immortal entities, but that they may exhibit a "mean time to failure"! That is they may destroy

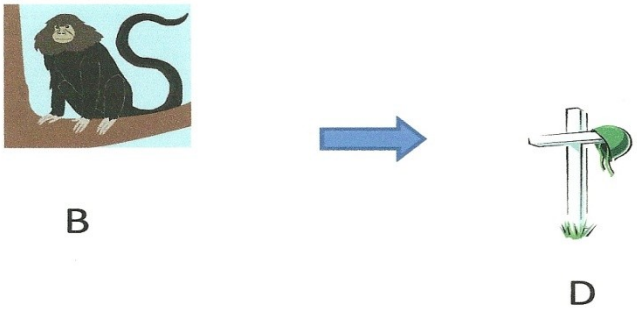
themselves: think of the movies “On the Beach” and “Dr. Strangelove.” This is the so called ***Enrico Fermi paradox***. Let us pursue this last point a bit further. Consider the following time line or string.



Slide 18, Exoplanet Advanced Civilization Time Line or String

Point **A** is the beginning of our Universe, point **B** is the beginning of an Exoplanet civilization, **C** is the time when the civilization becomes sufficiently advanced to participate in interstellar communication, the cyborg stage, with other advance civilized Exoplanets or “Worlds” and **D** is the date of the demise of the Exoplanet civilization according to the *Fermi Paradox*. Only if TODAY were at time (2) would a particular advanced civilization have the capability for interstellar communication that could be intercepted by us. There are numerous values that we could choose for these dates. We will select some arbitrary numbers for them – all very speculative. Since the beginning of our Universe some 13.7 billion years have transpired from **A** to TODAY. For simplicity in numbers let us assume that after 13 billion of those years civilizations could begin and start to flourish, that is the time between from **A** to **B**. Next let us suppose that intelligent civilizations grow and mature to start to be interstellar communicators over, say, 500 million to ten billion years – the time between **B** and **C**. However the more important parameter is the estimation of how many years after a civilization reaches and remains in a stage of great advancement, say the cyborg stage **C,** and has evolved with the capability of interstellar intercommunication, before they either self destruct or have conflicts like the “Star Wars” sagas and obliterate each other or be destroyed like the dinosaur extinction. Although possibly optimistic I propose 10,000 years from **C** to **D** – something like a system’s mean time to fail. This is a “blink-blink” situation with some civilizations blinking off at time **D.** Therefore laid time-period-to-fail after time-period-to-fail or **C** to **D** times (that is assuming no overlap) some one-billion years divided by 10,000 years equals some one hundred thousand (10^5) civilizations that could exist in our Universe and never “overlap” or intercommunicate. Essentially we would have a string of one hundred thousand or 10^5 advanced civilizations at least one member of which is “operating” at any one time, but no interaction with one another. We estimate that there may exist as many as 100 sextillion or one followed by 23 zeros (100,000,000,000,000,000,000,000 or 10^{23}) Exoplanets evolving with intelligent life. Clearly this number must be greatly reduced due to the fact that many such “Worlds” are not in sufficient “habitable zones” to mature or that they may not reach what we have called the ”cyborg

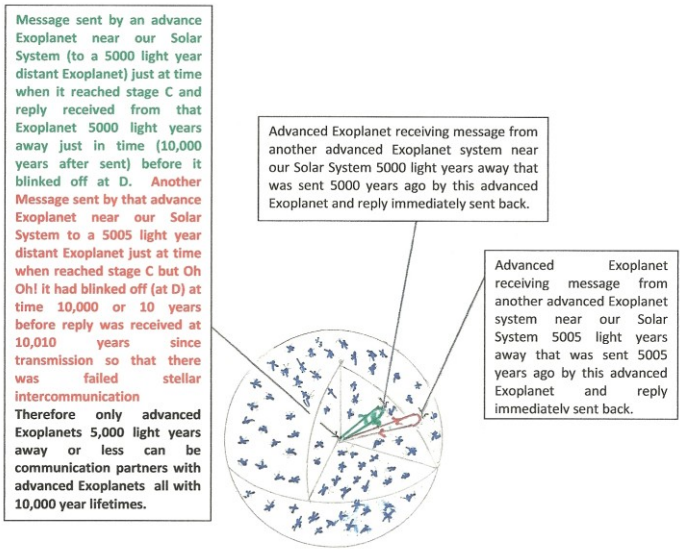
stage" and start intercommunicating. Let us arbitrarily reduce the number by 100 to down to 10^{21}. Assuming a ten-thousand-year mean time to failure, of this number only $10^{21}/10^{4} = 10^{16}$are available and intercommunicate at any one time – say TODAY(2). But only those Worlds that are clustered together close enough to communicate with each other in a time span less than 10,000 light years apart could communicate in time before their demise **D**.



Slide 19

Let us suppose that the average distance apart of stars in our Galaxy is 5 light years (see, for example, http://boojum.as.arizona.edu/~jill/EPO/Stars/galaxy.html), so that minimum back and forth intercommunication time would average some 2X5 = 10 years. But during their advanced phase of 10,000 years (**C** to **D**) a given advanced civilization could intercommunicate with other advanced civilizations that were within at most 5,000 light years (communiqué transmitted with the speed of light at the beginning of their advanced cyborg stage **C** and the reply received just before their demise **D**). That is they could communicate with any advanced interstellar communicating civilization within 5,000 light years. Since there are about 5 light years distances on average between stars (and their assumed Exoplanet companions) there would be an intercommunications "range" of 1,000 Exoplanetary systems in any direction. Let us be specific here: we could send a message off (at the speed of light) and have it received by an advanced civilized Exoplanet at a 5000 light year distance in 5,000 years. If they made an immediate reply, then we would receive a reply from the advanced interstellar communicating civilized Exoplanet within another 5,000 years. So if, on average, they are 5 light years apart, *there would be some one thousand intercommunicating Exoplanets in any given direction*, so the spherical volume around them, ($4/3\ \pi\ (1000)^3 = 4.2 \times 10^9$), would contain about 4.2 Billion such Exoplanetary systems to intercommunicate and for us to eavesdrop on.(Of course a message sent by stars and their possible Exoplanet companions on each side of a spherical volume of stars would have to be within 5,000 light years of each other for intercommunication. That would require a spherical collection of stars exhibiting

of 5000/2 = 2500 light years radius or 64 times fewer stars. But we are only interested in our Sun and Earth being in the center of the intercommunicating group or volume for eavesdropping not on the surface.) As a further example suppose an advanced interstellar communicating civilization were near our Solar System and had just entered the advanced stage and had a 10,000 year "lifetime." Furthermore, assume that Exoplanet was interconnecting (or sending messages back and forth) with an advanced Exoplanet exactly 1000 Exoplanets or 5,000 light years away in a given direction on the edge of the aforementioned spherical volume. If the receiving Exoplanet immediately replied with a message (propagating at the speed of light), then the message would be received by the sending Exoplanet just before it blinked off and the intercommunication complete. If, on the other hand, the sending Exoplanet attempted a intercommunication with an Exoplanet 1001 Exoplanets or 5,005 light years away, then the reply message reach the sending Exoplanet in 10,010 years – *too late since the receiving Exoplanet had already reached its demise* so no intercommunication! But not much of a conversation with the 5000 distant Exoplanet. If, however, at a distance of 4995 light years a more relaxed chat – actually like an exchange of letters, could be accomplished over 10 years. Consequently, we are really talking about interstellar correspondence not conversation!



The sphere of radius 5,000 light years containing stars in the neighborhood of our Solar System containing about 4.2 Billion stars of which about 420,000 Exoplanets, having advanced intelligence and interstellar communications capability will simultaneously exist – each having a mean time to failure of 10,000 years.

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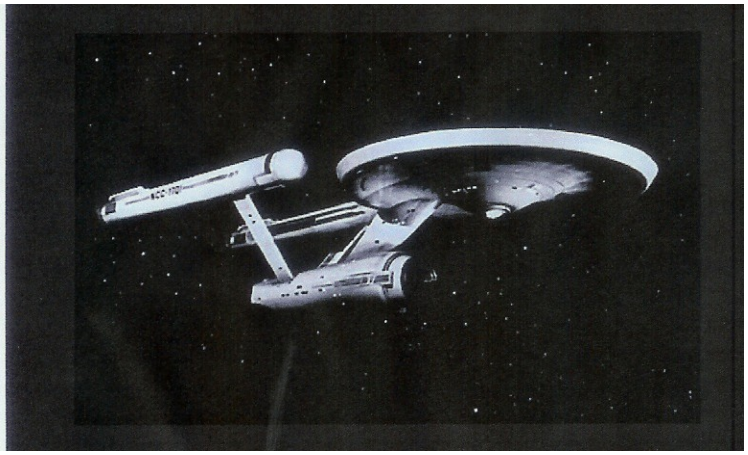
Slide 20

Not all of these Exoplanetary systems would have planets in the habitable zone and not all will become cradles of intelligent life forms. Here again we guess that one out of one hundred will arise as advanced civilizations that development interstellar communications. Additionally we do not know how many will be "blinked on" at the same time according to Fermi's Paradox and therefore able to be participants in an interstellar intercommunications network. Again we guess that only one out of one hundred of them will be simultaneously blinked on. Thus we have calculated that their potential interstellar intercommunications network will contain about ($4.2 \times 10^9/100 \times 100 = 420{,}000$) four hundred and twenty thousand members or possible Worlds.

The problem is that not only have we selected some very shaky and arbitrary numbers (e.g., not considered galaxy-type regions of our Universe having more dense populations of stars and, therefore, advanced intelligent life forms capable of intercommunication), but we have entirely neglected civilizations rebuilding and, so to speak, blinking back ON – something like portrayed in "Planet of the Apes"! Furthermore, like we earthlings there will also exist "Explorer groups" sent out by these advanced civilizations. Communications with and among such groups in the intercommunication-range sphere will also be subject to interception. Think "Starship Enterprise"!



Slide 21, Starship Enterprise from "Star Trek"

Also there is no reason to rule out Exoplanets hundreds of thousands if not millions of light years away from our local cluster. For entities that have much longer lifetimes, are not obliterated in millions of years and are populated by cyborgs having, for example, a hundred-million-year life times so that a million light-year travel to the environs of planet Earth would be like an afternoon walk in the

park and their intercommunication range sphere could be billions of light years across! On the other hand, an omnidirectional wave pattern has been assumed whereas transmissions may be projected along narrow beams. But it would appear, on balance that the chances are *we **would** "encounter"intelligent extraterrestrial creatures soon after we fabricated and operated detectors sensitive enough for eavesdropping or intercepting their messages!* But, hold on, so far I have assumed that advanced extraterrestrial civilizations would want to communicate among themselves and with other like civilizations in our Universe. It is my belief that intercommunication is an essential feature of all life forms: from Indian smoke signals to laser inter-satellite communications—even animals intercommunicate for very practical reasons such warning or danger signals or the dancing of bees to communicate paths to nectar. I may be wrong, but there is somehow a basic need of all creatures to chat and even gossip!

5. What would be the Proper Detectors Sensitive Enough to Sense their Intercommunications?

We ponder that, with the identification of a myriad of Exoplanets by NASA's Kepler Satellite, even in the limited regional volume of our Universe near our Solar System, are we very near to the cataclysmic event of extraterrestrial interaction? The September 8-15, 2014 edition of *TIME Magazine* (p. 85) posed our question "How soon will we discover Alien life?" They assumed 100 billion star systems that might support life and that "Estimates of the number of *active* alien civilizations range from 10,000 to one million." Of course "discovering alien life" is a far different matter than estimating their existence! One wonders, however, why such "advanced" entities would bother with us today at all? In my opinion it would highly improbable that intelligent entities would be much interested in us and try to travel or communicate with us – how many times have you attempted to communicate with an anthill? On the other hand, it seems likely to me that there would be interstellar intercommunication among intelligent extraterrestrial entities or their "ships" and we might be able to eavesdrop or listen in to their chatter ("gossip"). Since interstellar space is mainly a high vacuum ordinary acoustic or sound communication would of course be impossible. Such alien entities might utilize radio, microwave or even Laser communication. The "Search for Extraterrestrial Intelligence" or SETI program assumes radio or microwave communication.

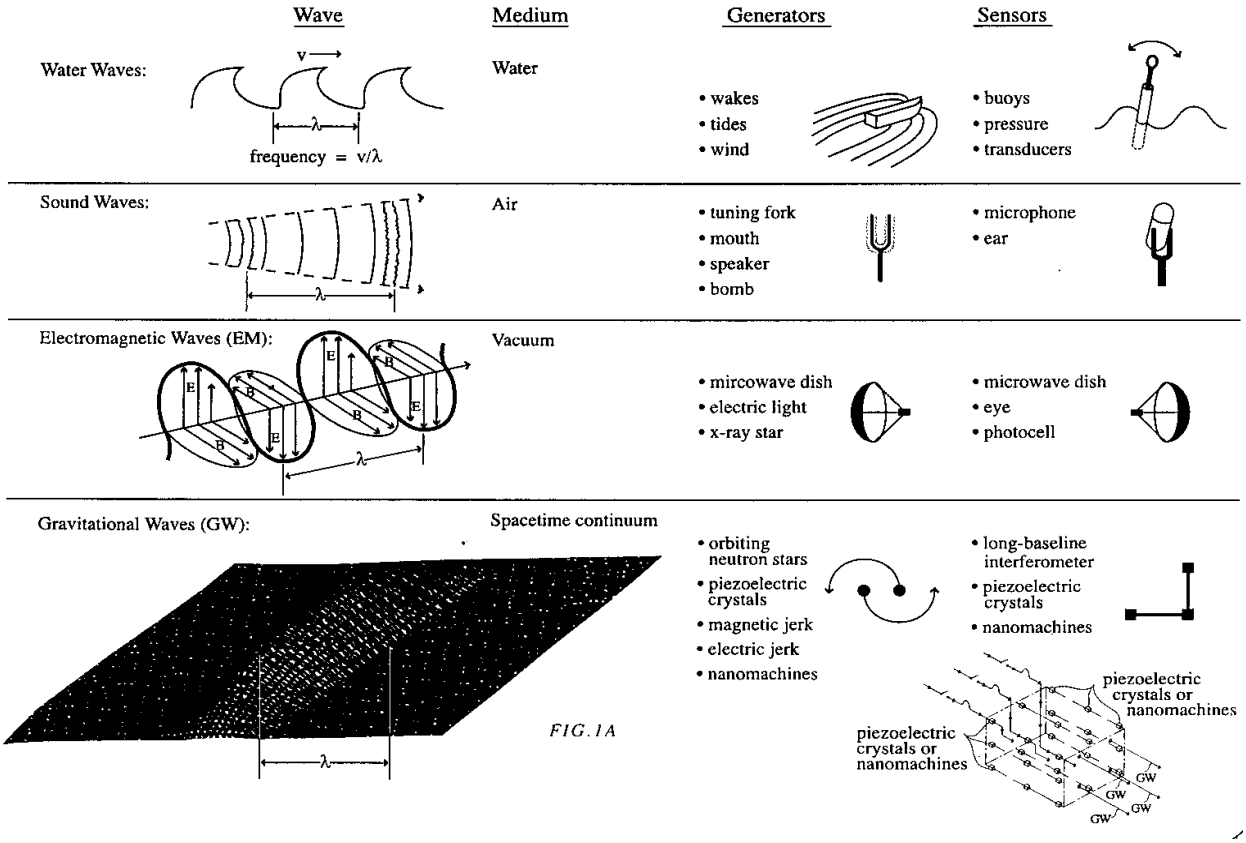
Search for Extraterrestrial Intelligence

SETI. But Electromagnetic not High-Frequency Gravitational Waves

Slide 22

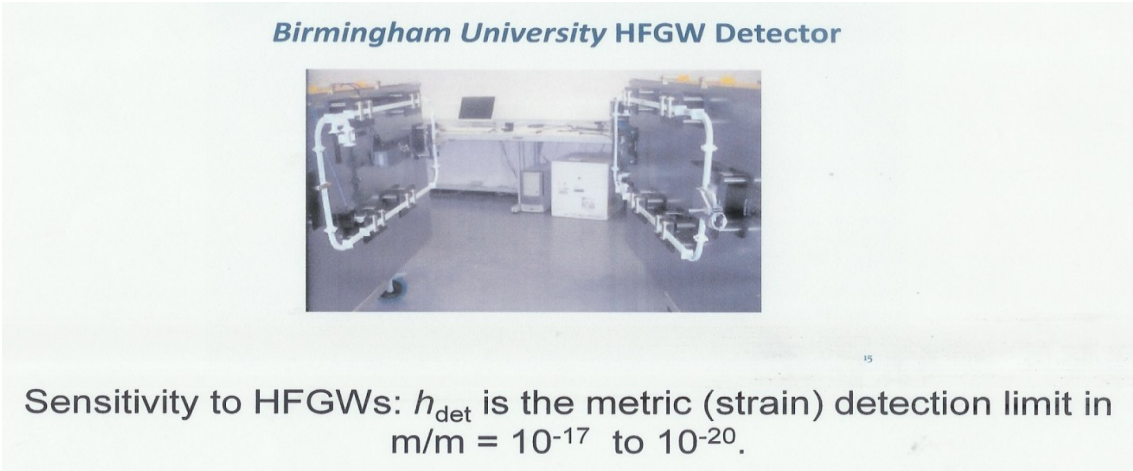
These are all modes of *electromagnetic radiation* communication. I seriously doubt that such intelligent creatures would choose electromagnetic radiation communication means since such radiation would be so easily attenuated or absorbed by intervening matter such as stars or other interstellar material. I suggest that the only appropriate means for interstellar communication would be to utilize a radiation that is not so easily absorbed: gravitational radiation or gravitational waves, which like gravity itself passes through most media completely unattenuated. Such radiation was originally proposed in 1905 by **Jules Henri Poincaré,** a famous French scientist and mathematician, and developed in a quantitative theory by **Albert Einstein** in 1918. Such gravitational waves were indirectly proven to exist by **R. A. Hulse** and **J. H. Taylor, Jr**. who were awarded the Nobel Prize for their work. This prompted the development of LIGO: The Laser Interferometer Gravitational-Wave Observatory (*Science* **256**, pp. 325-333) primarily due to the work of **Kip S. Thorne** at Caltech. While LIGO is designed to detect gravitational waves having an extremely low frequency (fractions of a cycle per second), which are theoretically established to be generated by the merger of two black holes, viable interstellar communication would require the use of High-Frequency Gravitational Waves (or HFGWs) in order to provide essential bandwidth (like "4Gigabyte " smart phones). Therefore it is concluded that to prepare for the eventuality of an intercept of interstellar intercommunication among intelligent extraterrestrial entities, we would be well advised to detect and listen to high-frequency gravitational waves and also to

prepare ourselves mentally and emotionally to “meet” such extraterrestrial entities electronically via such HFGW communications.



Slide 23, Gravitational Waves

With regard to High-Frequency Gravitational Waves, there are currently six high-frequency gravitational wave (HFGW) detectors or receivers in operation or under development. They are as follows:



Slide 24

INFN Genoa HFGW Detector.

16

Sensitivity to HFGWs: h_{det} is the metric (strain) detection limit in m/m = 10^{-17} to 10^{-20}.

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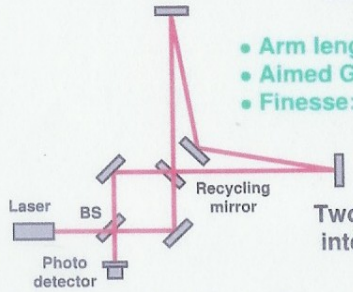
The National Astronomical Observatory of Japan 100MHz HFGW Detector.

UNIVERSITY OF BIRMINGHAM

Development of 100MHz GW detectors at National Astronomical Observatory of Japan

- Arm length: 75 cm
- Aimed GW frequency: 100 MHz
- Finesse: 100



Two synchronous recycling interferometers were built!

Synchronous recycling Interferometer (Concept: Drever 1983)

17

Sensitivity to HFGWs: h_{det} is the metric (strain) detection limit in m/m = 10^{-17} to 10^{-20}.

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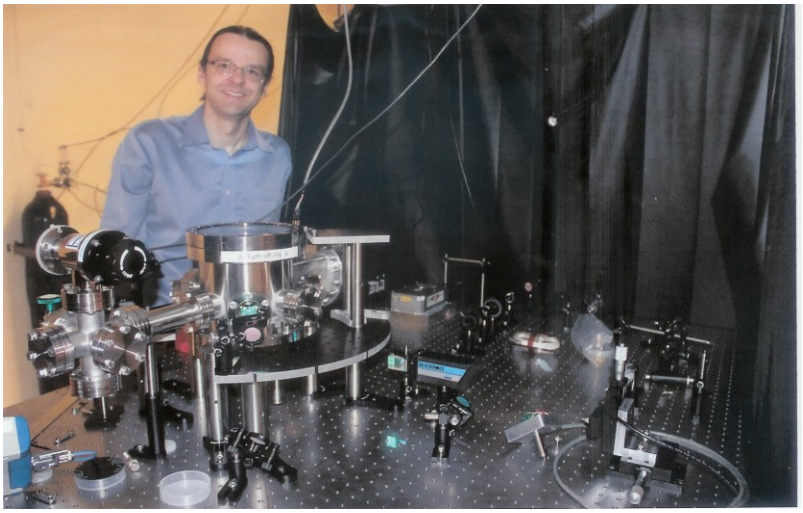
Stanford/University of Nevada HFGW Detector

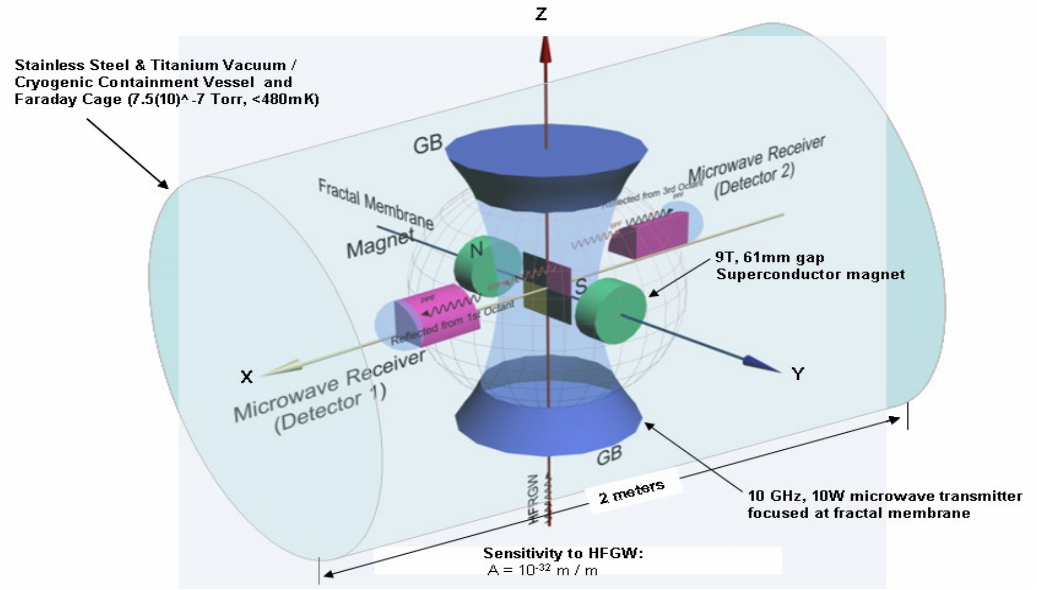
50 to 300 kHz



Slide 27

And the two most recent and *probably much more sensitive High-Frequency Gravitational Wave Detectors* under development:

Notional Drawing of Li-Baker Detector effort of Chongqing University in China, High-magnetic-field Center of Chinese Academy of Science (construction of high background magnetic field) and Southwest Jiaotong University in China (so far the Li-Baker would be the most sensitive detector of weak- signal high-frequency gravitational waves). Under Development October 2014



Li-Baker High-Frequency Gravitational Wave Detector

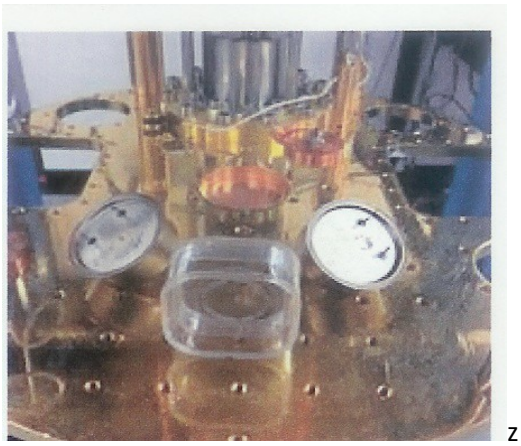
Journal of Modern Physics, 2011, 2, 498-518, http://www.gravwave.com/docs/Li-Baker%20%20EPJC%20%20Vol.%2056,%20pp.407-423.pdf

American Institute of Physics Proceedings 969, 1045-1054, http://www.gravwave.com/docs/Proposed%20Ultra-High%20Sensitivity%20HFGW%20Detector%2005-15-08.pdf

Slide 28

Gravitational Wave Detection with High Frequency Phonon Trapping Acoustic Cavities

Maxim Goryachev and Michael E. Tobar, November 3, 2014, ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, University of Western Australia



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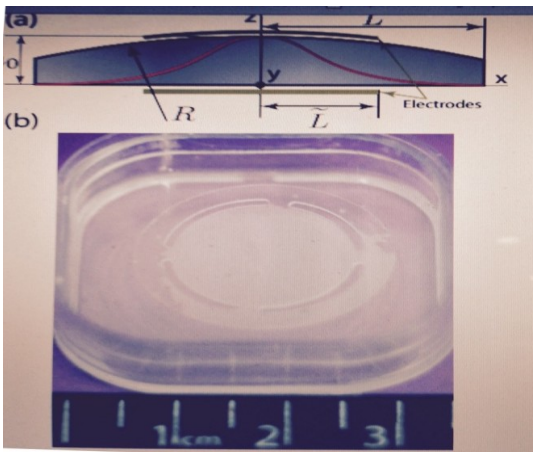
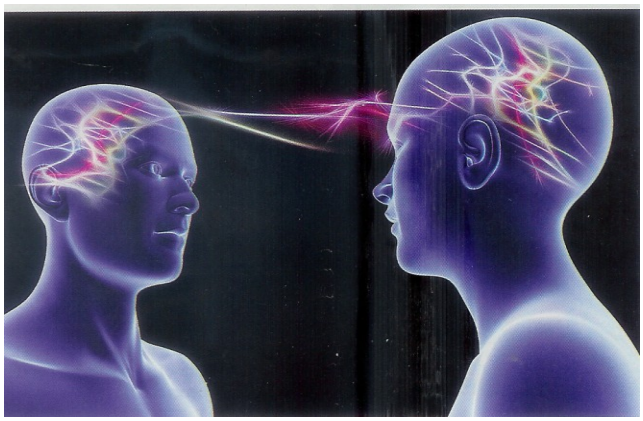


Slide 29

If natural selection exists everywhere in the Universe, then such extraterrestrial entities must have those qualities that help ensure permanence. As I have already stated: Why, then, would "they" want to engage in communication with a species that has a limited life span and far lower intelligence such as "earthlings"? One probable evolving alien life form would involve the replacement or repair of their "parts" especially if they were largely composed of electronic components as we predict for human life forms. As we have stated such cyborgs would be essentially immortal. Also it is essential to identify and quantify the means of their interpersonal intercommunication. Again an obvious conclusion is that evolution will produce some form of direct brain-to-brain or mind-to-mind intercommunication and we would be eavesdropping on "them" using High-Frequency Gravitational Wave detectors. Would our National Security Agency be able to "understand" or "decode" such an alien brain-to-brain or mind-to-mind communication?



Slide 30, *Science* **345,** p. 262

6. Conclusions: How do we encourage and prepare for the cataclysmic event of extraterrestrial interaction?

We encourage and prepare for the cataclysmic event of extraterrestrial interaction in two major ways:

1. Conduct research and development of high-frequency gravitational wave (HFGW) detectors or receivers. There are now (2015) six either fabricated or under development. So far those HFGW detectors that have actually been built may not have the required sensitivity.

2. Conduct research in cryptography with special attention to the possible interception of "brain-wave" communications from extraterrestrial communication intercepts. This will involve the teaming of neuroscientists and cryptographic experts, the later probably from National Security Agency and the former from research groups such as the UCLA Brain Research Institute.

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Before I conclude my remarks on interstellar interaction among intelligent entities allow me to tell you about a hypothetical means for current homosapiens to visit other worlds: The answer of course is to put people into suspended animation. That is to pickle people. As the story goes a process for pickling people was made operational just in time for the first interstellar mission in 2050. Married couples were selected and pickled in pairs. The concept was that after each coupled lived their useful lifetime and made and recorded amazing observations along the way they would unpickle the next couple and then retire so to speak until they passed away. All went well until the husband of one of the couples went around and unpicked all of the wives. This caused the termination of the voyage and signals the end of my talk.

Slide 33