Gravitational Waves & Exoplanets: New Frontiers in Science

By Robert M L Baker, Jr., PhD

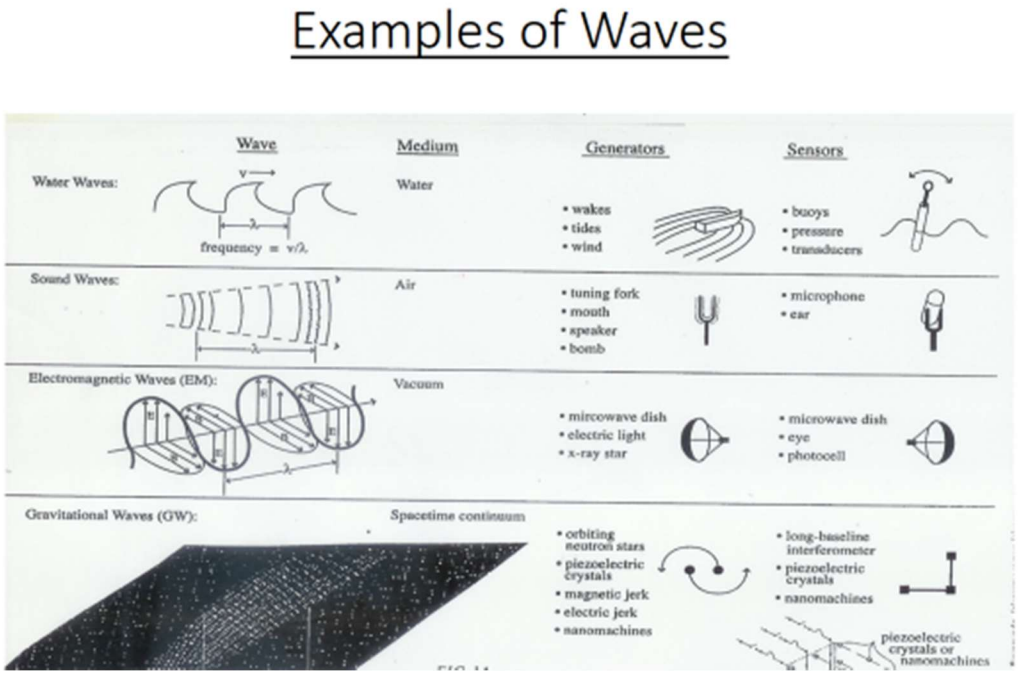
INTRODUCTION

A mere three years ago, the public had never even heard of "Gravitational Waves" or "Exoplanets." Today, popular scientific articles are flooded with these topics. I will explain to you what these topics involve and their great importance to both science and to our planet and humanity.

Although we cannot "feel" them, our planet is being bombarded by gravitational waves and although we cannot easily "see" them, we are surrounded by exoplanets – planets that may be the cradles of other intelligent life in our Universe. First, I will discuss Gravitational Waves; second, I will take you on an imaginary tour of exoplanets. And third, I will tell you what these two important scientific topics have in common.

1.0 GRAVITATIONAL WAVES

Let us consider a number of different waves:



We feel waves on our body when we swim in the ocean. We hear sound waves. We see other people by means of rays of light, which are part of what are defined as Electromagnetic or EM waves. BUT there are other INVISIBLE waves, Gravitational Waves or GWs, so far not easily sensed by us.

These Gravitational waves are ripples in what Albert Einstein called the "fabric of spacetime." Because we live in a three-dimensional world we cannot visualize spacetime because it is FOUR DIMENSIONAL. We can visualize going North at 5 mph and going West at 21 mph and going Up in an elevator at, say, 10 feet per minute, BUT "how fast do we go" from 4pm to 5 pm? It is difficult to imagine time being a dimension

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! That does not mean that every star has a planet, but one may have 8 or 9 like our Sun, some may have none, some may have 12 or more, but on average assume one exoplanet per star.

References and supporting analyses in Gravitational Waves: the World of Tomorrow, with Exercises - by Robert Baker, December 2016

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So according to the "Fermi Paradox" the frequency of such inter-civilization communication is dependent on the longevity or duration – that is, the time between C to D (we symbolize this time period by the symbol ***d*** which equals **D – C**):

Exoplanet Advanced Civilization Time Line or String

A Beginning of Universe
B Birth of a new Exoplanet civilization
C Interstellar communications capability achieved
D Demise of an Exoplanet civilization

NOTE: All of following analyses are discussed in the foot-noted Book.

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The longevity of advanced civilizations might be enhanced by genetic engineering or by a blend of biology and replaceable electronics that is "Cyborgs."

Science **340, p. 1162**

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Brain Implants Using Fabric Flexible Circuits

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So the life for a person and for an advanced civilization could be quite long. Let's make an educated guess that the time between C and D is 400,000 years as suggested by the following Table.

Table 1. The Length of Time in Years between a Civilizations' Emergence of Cyborgs and/or Interstellar Communication Capability and their Demise, **C** to **D** or *d*

No. of Generations→ Generation length, years ↓	1	4	40	400	4,000	40,000
25	25	100	1,000	10,000	100,000	1,000,000
100	100	400	4,000	40,000	400,000	4,000,000
1,000	1,000	4,000	40,000	400,000	4,000,000	40,000,000
10,000	10,000	40,000	400,000	4,000,000	40,000,000	$4x10^8$
100,000	100,000	400,000	4,000,000	40,000,000	400,000,000	$4x10^9$
1,000,000	1,000,000	4,000,000	40,000,000	400,000,000	4,000,000,000	$4x10^{10}$

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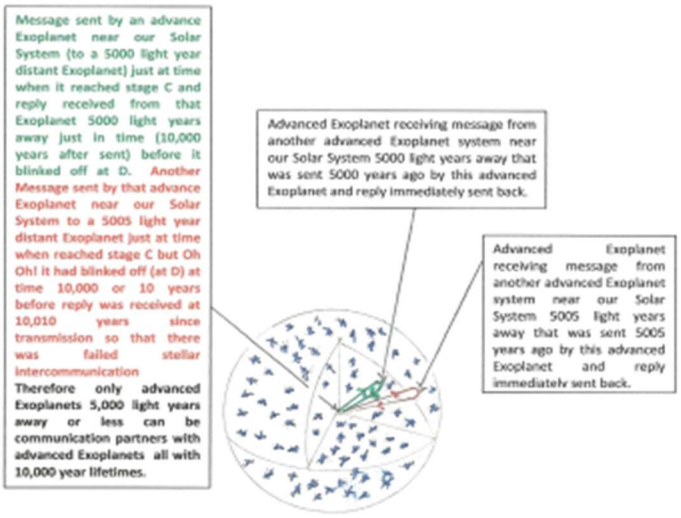
OK, so then how many messages (more like letters or E-mails) can be sent and received?



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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Wow! This looks really complicated! The idea, however, is rather simple. An exoplanet advanced civilization needs to be close enough to another exoplanet civilization that is still “alive” and has interstellar communication capability, such that a message sent when it’s interstellar communication capability is achieved, will still be “alive” (but probably greatly changed) when a return message from that other exoplanet civilization is received! When all this is put together with observation that stars are about 5 light years distance from one another, we find that the frequency of their messaging is, under one set of educated guesses, about 1,500 per day at our Earth! Some of the logic behind these educated guess is exhibited in the slides: The 0.1 ***d*** is essentially communications sent out to a particular other intelligent exoplanet every one tenth of the exoplanet’s lifetime.

Number, N, of potential intercommunicating advanced civilizations as a function of the years between **C** to **D** or ***d***

d years between **C** to **D**	N
4000	1.48
40,000	14,800
400,000	**1.48×10^8**
4,000,000	1.48×10^{12}
40,000,000	1.48×10^{16}

Potential Frequency of Intercepts

- In the numerical example for the 0.1 ***d*** case there might be 550,000 possible messages to intercept each year or about **1500 per day**. It is also interesting to note the distance of the stars/exoplanets in light years for 0.1***d*** and 0.001***d***. These distances are, for the most part, in our Galaxy.

How do we decipher a message intercepted from an advanced exoplanetary civilization? It will not be in Morse code! The National Security Agency (NSA) will be challenged since the advanced intelligent beings probably communicate thoughts and visions directly.

What will we learn from the intercepted messages? Here is where mankind may have great benefit from learning what the messages are about and "tell" us how to improve our way of life. But, this intercept will also be a Cataclysmic Event and may even lead to religious and other turmoil on our little planet! So intercepting messaging among advanced exoplanet civilizations would be amazing, but actually viewing an exoplanet might even be better!

It has been suggested by Steven Hawking ("starshot") that small microchip starcraft be propelled by powerful laser beams acting against small solar sails, to the location of a nearby star group about 4 light years away (where an exoplanet has been spotted). Problems are that such laser beams might destroy the fragile solar sails – called ablation -- and as the Earth rotates the solar sails are essentially eclipsed by the Earth! So here is a second application of high-frequency gravitational waves that are not absorbed by most anything (therefore no ablation) and theoretically (to be proven by experiment) reflected by small high-temperature superconducting mirrors in the microchip starcraft. Such starcraft might be in the shape of Ping Pong Balls and involve nano electronics for the attitude control and refrigeration and using modulation of the tiny mirror to be the communication link back to Earth.

Starcraft Flotilla

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A theoretical 200-meter long, high-frequency gravitational wave generator could, by guestimates, produce a high-frequency gravitational propelling flux (or flow of propulsive energy) more than 10,000 times the maximum solar flux at the Earth.

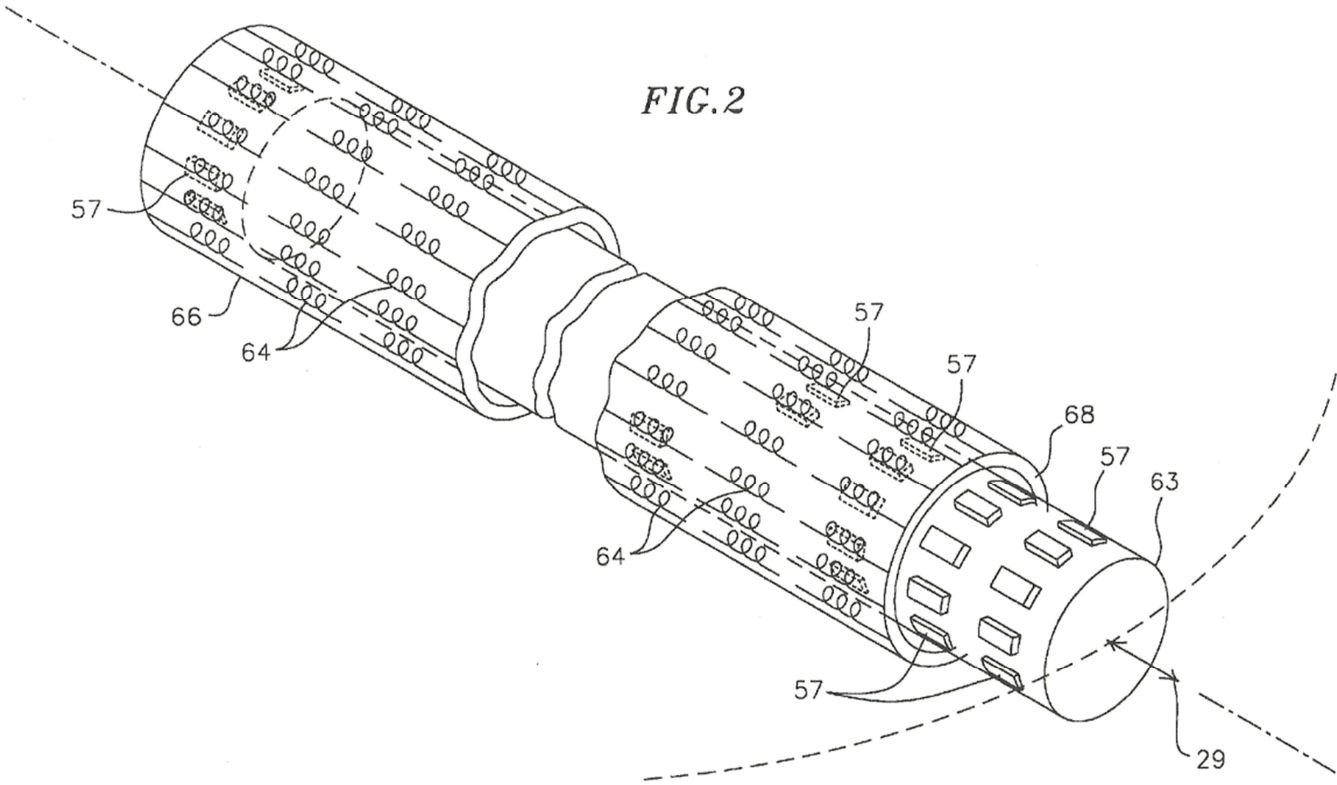

FIG. 2

What might these exoplanet neighbors of ours look like? Since locomotive and manipulative activities would be by remote brain control, no limbs or hands would be needed. The least covering area for a given volume is a sphere, so that would be their form.

What might an Advanced Exoplanetary Being look like?

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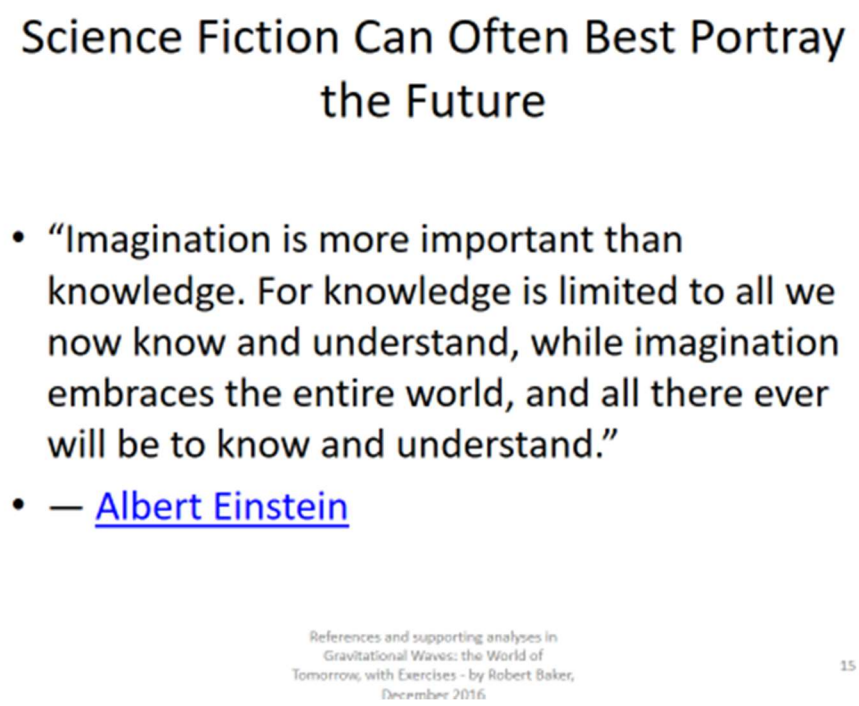
Essentially, we might observe an advance intelligent exoplanetary civilization to be like a happy group of spheres, studying physics and art, dancing around and periodically osculating with one another. Bowling might be their main sport and sex would be by means of what Woody Allen called in his movie “Sleeper” an “Orgasmatron.” Now we humans might even intercept the plans to such a titillating device – far better than the plans for a Star-Wars weapon!

However, this intercept might also be a Cataclysmic Event and may even lead to religious and other turmoil on our little planet!

This all extremely imaginative and I often utilize science fiction to illustrate a point, BUT



Thanks for your indulgence – Any questions?

Q: Why cannot the very sensitive Laser Interferometer Gravitational Observatory or LIGO be utilized to intercept interstellar high-frequency gravitational wave communications or emissions from the Big Bang?

A: The easiest explanation to understand the LIGO frequency limitation is to visualize old radio antennas and modern satellite-dish antennas. The former were utilized to detect rather long radio low-frequency waves and would often consist of a long antenna wire. The latter is utilized to detect very high-frequency microwaves and consist of relatively small satellite dishes. It would be impossible for a radio wire antenna to detect high-frequency microwaves, just as the LIGO "antenna" cannot detect high-frequency gravitational waves.