The search for extraterrestrial intelligence

by Urias Echterhoff Takatohi

Does an intelligible signal come from natural cause or intelligent design?

The search for extraterrestrial intelligence (SETI) involves a number of projects. All of them have the objective of finding evidence of extraterrestrial intelligence through radio signals from space. The first of these projects was led in 1960 by Professor Frank Drake, astronomer and now director of SETI Institute. Project Phoenix is the main project of the institute, with an annual budget of $4 million to $5 million. It uses large radio telescopes to receive electromagnetic signals from nearby stars like the sun, that are less than 200 light years away. Besides the SETI Institute, other research institutions working on similar projects include: SERENDIP (*Search for Extraterrestrial Radio Emissions from Nearby Developed Intelligent Populations*); SETI@Home at University of California, Berkeley; Southern SERENDIP in Australia; Harvard SETI Group; and others.[1]

Why do scientists spend all their efforts on these activities? A quick glance at the history of human thought may help us understand. Up to the 19th century, most of the Christian world believed that the cosmos and everything in it was the result of God's creation. Scientists paid little attention to questions about the origin of the universe and of life.

However, since the 17th century, scientists discovered regularities in nature that could be explained by comprehensive laws, sometimes expressed in a precise mathematical form. These natural laws and theories allowed predictions of phenomena and the development of technologies to control even nature itself. As a result, by the mid of the 19th century, there developed the idea that a creator God was unnecessary to explain natural phenomena. The cosmos has become the ultimate reality. In this worldview, called naturalism or materialism, the search for an explanation of the origin of everything without reference to a Creator was a logical need.

This search for origins resulted in the theory of biological diversity, which eventually led to Charles Darwin's publication of *On the Origin of Species* in 1859. About the same time, Pasteur approached the question of the origin of life experimentally, demonstrating that the old ideas of spontaneous generation were flawed. Nonetheless, the naturalistic worldview demanded that life appeared by an undirected combination of chemicals following the laws of physics and chemistry without the guide of an intelligent creative agency. Ernst Haeckel, a German biologist, and Thomas H. Huxley, Darwin's supporter, expected the process to be simple, for as yet then the details of living cells were unknown.

Despite early optimism, no adequate theory for the origin of life has been provided, even though textbooks in biology still quote the hypotheses of Oparin, the Russian biochemist (c. 1930) and the experiments of Stanley Miller at the University of Chicago (1952), as advances in that direction.

Although these experiments fail to explain the natural origin of life, naturalistic or materialistic assumptions require a belief that life appeared without the aid of an intelligent God. Considering the theory usually cited regarding the history of the universe and the Earth, appearance of life on the planet

occurred rather quickly. (According to this theory, the age of the universe is 10 to 20 billion years old, the crust of Planet Earth would be 4.5 billion years old and life appeared about 3 billion years ago.) Considering the existence of an estimated 400 billion stars in our galaxy, and about 100 billion galaxies, it would be reasonable that many of these stars might have planets like our Earth in which life may have developed as it did here, resulting in technological civilizations able to broadcast radio messages. This reasoning based on a naturalistic worldview is the motivation behind SETI projects.

The methodology

Several SETI projects search for narrow band radio signals, with a definite frequency like radio or TV signals. Natural sources of radio waves from space generally produce wide band signals, while radio or TV transmitters present a specific frequency. Making an analogy with sound waves, a radio or TV station emits a single note like a flute, while natural sources of radio waves produce a sound like a waterfall. Intelligent extraterrestrials, it is expected, would make radio transmitters similar to ours. It is also expected that any intelligent being who wanted to broadcast electromagnetic waves through space would use a frequency near 1420 MHz.[2] If a signal with such characteristics is detected, one should verify that it is not from a human source, since our radar devices, communication satellites, and other kind of human sources emit such waves.

If the appropriate signal is ever detected, the next step would be to verify whether there is any information in it like radio waves from our radio or TV stations. Information may be introduced in electromagnetic waves by small intentional variations (modulations) in frequency or amplitude. Present projects are working only to search for the proper signal. The search for a message in a signal, if one is found, will require new instrumentation.

Another question concerns the possibility of understanding the message. If extraterrestrials are able to broadcast radio signals, they probably understand basic principles of science and mathematics and would use science and mathematics to build a common language.

Since the beginning of this research 40 years ago by Frank Drake, no convincing signal has ever been found.

Success in fiction

Carl Sagan, a recently deceased astronomy and space science professor at Cornell University and an enthusiastic science promoter, wrote a novel, *Contact.*[3] The story describes the problems scientists have to face to obtain funds for their research, and proposes that a radio signal with the required attributes, coming from Vega, a star in Lira, 26 light years away, has been detected. The discoverer notices that the signal is transmitting a long sequence of prime numbers. As no known natural phenomena generates signals with a structure so complex and specific as prime numbers, the astronomers in this fictional account become convinced that the broadcast is from an intelligent source.

But how do we know whether or not a signal comes from a natural cause or from the design of an intelligent being? The best evidence that some effect was designed by an intelligence is its *specified complexity.*[4] To understand *specified complexity,* consider the following example:

The sequence with the first two Roman characters, AB, is specified but isn't complex.

A random sequence with 40 characters, such as, GIV JFJMUUDWQCNTQVT NVXYALZFHMBHULVCXRTPF, is complex but not specified.

However, the sequence, SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE, is both complex and specified.

One can see the difference by determining the probability for obtaining each sequence choosing characters by chance. Since each position in the sequence has 27 options (26 characters plus a blank space), a total of 729 (27 x 27) sequences with two characters may be achieved. The specified sequence with two characters is one in 729 sequences. On the other hand there are 27^{40} (= 1.797×10^{57}) different sequences with 40 characters. (The number 1.797×10^{57} is equivalent to 1797 followed by 54 zeros!) This number is so great that we can hardly grasp its meaning. It is more than 600 times greater than the number of all the protons and neutrons of Planet Earth added together. So a specific sequence made of 40 alphabetic characters is one in 1.797×10^{57} sequences. To get such a specific sequence of this size by choosing random characters would be practically impossible. By experience, we know that such complex specified sequences are the result of an intelligent design.

Summing up, the search for extraterrestrial intelligence seeks radio waves with characteristics similar to those produced by transmitters constructed by humans. If such a signal is found, the next step would be the search for specified complexity in it. In other words, scientists are searching for some extraterrestrial radio transmission that unequivocally may be recognized as a product of an intelligent mind.

Unrecognized success

Great progress in biological knowledge was achieved in the last half of the 20th century. Many details, previously unthinkable, with respect to cell structure and function were discovered at a molecular level. One of these discoveries is the DNA molecule: the key for information storage and transfer in genetic material.

The DNA molecules have two complementary strings made of four different constituents, named bases or nucleotides that we will represent as A, G, C , and T. (We will not employ the usual bi-

ological or biochemical terminology.) A string of symbols may be used to convey a message as in written text. One may wonder, is it possible to have a language written with only four symbols?

In reality, only two symbols are needed to store written data. All coding in digital computers is made with strings of two symbols, 1 and 0. The text you are reading was originally composed using such a computer and uses almost 100 different printed symbols. How is this achieved? Strings of 1 and 0 are arranged in groups of eight as shown below. Since for each position out of the eight you have two choices, 256 (2x2x2x2x2x2x2x2) different symbols may be codified with strings of two symbols in groups of eight as in the example below.

11001010 01010010 10001011
11101101 01000101 10110111

Likewise in DNA. Four different symbols arranged in groups of three can define 64 (4x4x4) different "characters."

How many bases are there in the DNA that encodes all the genetic information of a living being? The number of bases is different in different species. A simple bacteria like *M. genitalium* has 580,000 bases in its DNA. The *E. coli* bacteria has sequences adding to 4,670,000 bases. The fruit fly *Drosophila* has about 165,000,000 bases. Human beings have DNA sequences with a total of about 3 billion bases.[5] The number of different sequences that can be created with 580,000 bases is a huge number that is hard to understand. It may be written as $4^{580,000} = 6.2 \times 10^{349,194}$. To write this number as a sequence of Arabic numerals, you would need 349,195 digits. Taking into account that a group of three bases represents a character in the biological alphabet with its 64 possible symbols, the genetic information of *M. genitalium* is equivalent to a text with 193,000 characters. This text you are reading has a little more than 11,000 characters. The genetic information of a human being with 3 billion bases would be able to make a text with one billion characters. That is equivalent to about 100,000 texts like this one. Even taking into account only about 5 percent of the 3 billion bases that are known to code proteins, the amount of information is staggering.

What is "written" in these genetic information "texts" in living beings? We know that it includes all the necessary instructions for the operation of a living being, even though we do not fully understand its complex biochemical "machinery."

Where did all this information come from?

Consider this essay you are reading. This was produced by an intelligence—in this case, a human being. No one can say that some automatic device has chosen characters by chance to compose this text, or that there is some natural mechanism that can put the letters in their correct places. The text is complex and specified enough to make it unreasonable to assume it appeared by chance or by an undirected natural cause.

If this is so with a simple essay such as this one, how much more so with genetic information, which is much more complex and specified than this text, and hence can be attributed only to an intelligent source. If this intelligent agency cannot be found on Earth, it must be an extraterrestrial intelligence. Biology and biochemistry since the mid 20th century, in their research about the molecular basis of life, have found clear evidence of the existence of extraterrestrial intelligence. Notwithstanding, naturalistic thought is so embedded in our culture that this achievement isn't being celebrated within the scientific community.

One does not need all this knowledge to arrive at this conclusion. Long ago, before the beginning of modern science, David wrote about God the Creator: "For you created my inmost being; you knit me together in my mother's womb. I praise you because I am fearfully and wonderfully made; your works are wonderful, I know that full well" (Ps. 139:13, 14, NIV).

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Notes and references:

1. See SETI Institute, available at http://www.seti-inst.edu/Welcome.html; What is SETI? available at http://seti.uws.edu.au/main/what.htm; SETI FAQ, available at http://www.space.com/searchforlife/seti_faq.html; Harvard
2. F. Drake, *Contemporary Radio Searches for Extraterrestrial Intelligence*. Available at http://www.seti-inst.edu/science/contemporary_radio.html
3. C. Sagan, *Contact: A novel* (New York: Simon and Schuster, 1985); Mass Market Paperback, 1997).
4. The expression "specified complexity" was introduced by William A. Dembski in *The Design Inference* (Cambridge University Press, 1998).
5. See: Functional and Comparative Genomics Fact Sheet, available at http://www.ornl.gov/hgmis/faq/compgen.html