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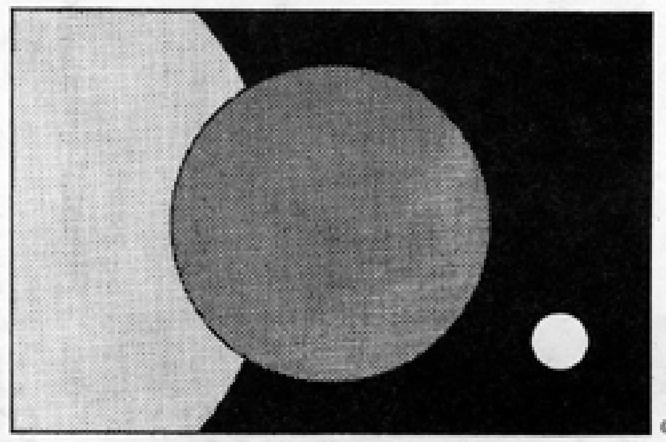
The SEnTlnel

By: Robert S. Dixon

The Flag of Earth



Its anthem is the wind in her trees
and the waves of her seas

The Flag of the Earth. The Sun (at left) is yellow, the Earth (center) is blue and the Moon (lower right) is white.

Before Man landed on the moon, there was a small group of people in the United States promoting the idea that the first flag planted by Man on an extraterrestrial body should be a flag representing the people of Earth, rather than just one nation. The underlying philosophy was that sooner or later Man would achieve the moon, and it was simply a matter of historical and political circumstances that enabled the United States to be the instrument by which it was first accomplished. Clearly, all inhabitants of Earth realized that it was the United States which led the way, so no loss of national recognition would have occurred as a result of not planting the American flag. The thought was that the reverse would be true: a showing of humility and sharing the accomplishment with all mankind would gain more respect than chestpounding. As history shows, however, the movement failed.

At that time the flag of the United Nations was the one being promoted. But in a sense, the flag of the United Nations is not really a flag of Earth. It is the flag of a specific international organization. It is probably not appropriate to fly the UN flag in association with any activity not specifically authorized and sponsored by the UN. The UN flag is intended to be meaningful among men and nations on Earth, rather than among Earth and other civilizations.

Now a true flag of Earth has been created, and is being distributed and promoted on a non-political, non-profit basis. In 1970, James W. Cadle from a rural area near St. Joseph, Illinois, authored this flag that depicts very simply the yellow Sun, the blue

Earth and the white Moon.

The flag illustrates the fact that Earth has only a single moon, and it is not negligible in size relative to its planet. This characteristic of the Earth-Moon system is unique in the solar system and may be very unusual in any stellar system. It has been speculated that such an association is necessary for the evolution of intelligent life, since the moon causes the tides that may have allowed sea creatures to gradually adapt to existence on land. This fact, together with the actual colors of the Sun, Earth and Moon, make a flag that is meaningful not only to Man, but perhaps to other civilizations as well.

Cadle was recently the subject of a National Public Radio program, and described how he distributes and promotes the flag using only his own resources. In his own words,

> "The Flag of Earth is ultimately a simple graphic symbol that stands for this planet and its immediate environs. As humanity matures and inevitably leaves its home, the need will be of a standard neither of a planet subdivision, nor, in a certain sense, of that planet as a whole. This yellow star will be the mark of home to a traveler long after the planet Earth is lost to the background. So also is this star primarily responsible for the very existence of humanity."

These ideas and sentiments are also true of searching for extraterrestrial intelligence (SETI). Accordingly, a Flag of Earth is displayed at the Ohio State-Ohio Wesleyan Radio Observatory, as a symbol of the fact that the ongoing search for other civilizations is in the largest sense being done by Man, with the individuals and organizations involved being only the instruments by which Man is carrying out this search.

Should the Flag of Earth be adopted as the unofficial flag of those that search for extraterrestrial intelligence? It would have to be on an "unofficial" basis because there is no ruling council to make it "official" (perhaps this is just as well). Write to **COSMIC SEARCH** and tell us your opinions.

Jovian Moon Appropriate Life Site?

The Voyager 2 spacecraft revealed that one of Jupiter's moons, Europa, is probably covered with an all-encompassing ocean that is 60 miles deep, topped off by a 5-mile thick crust of ice. The ice may serve to protect the ocean environment below from the rigorous conditions of space, and hold in the heat generated internally by the satellite. Thus the ocean may be at a reasonable temperature, and hence be the abode of life, similar to the way in which life began in the Earth's oceans.

These suppositions were made by Richard C. Hoagland, a NASA consultant, in the January 1980 issue of *Star and Sky*. Hoagland had previously suggested that the Pioneer 10 spacecraft carry the message plaque from Man beyond the solar system.

The Origin of the Elements

The story of how the chemical elements were originally created, and of Man's gradual understanding of that story, was well told in the Nobel lecture by Arno Penzias on the occasion of his Nobel award in Physics in 1978. His telling of the story which was published recently* (**Science*, August 1979) is a fascinating historical account.

By the 1930s it was known that the lightest elements Hydrogen and Helium were created at the beginning of the universe (the Big Bang), and that Helium had been built up from the simpler Hydrogen atom by progressively adding neutrons and protons to the nucleus. In the 1930s it was also suspected that this building process was continued in the cores of stars to create the heavier elements. By the early 1940s it was realized that this could not occur because adding either a proton or a neutron to a Helium nucleus does not produce a stable result. The new nucleus immediately comes apart again into Helium and whatever was added. Two alternative possibilities for creating heavier elements in the cores of stars were also considered but rejected. The first involved combining two Helium nuclei to form Beryllium, but this again is an unstable result. The other possibility was to combine three Helium nuclei to form Carbon. This would be a stable result, but the probability of getting three Helium nuclei together all at once is so small that this alternative did not seem plausible.

Having reached an apparent dead end in what might be done inside stars, physicists in the 1940s renewed their investigation of ways in which the heavier elements might instead have been created by the primordial Big Bang. Their search was unsuccessful; no explanation for the existence of the heavier elements could be found.

By the 1950s a great deal more had been learned about the physical conditions that exist inside stars. In particular, the temperature and pressure were found to be much higher than previously believed. This led Edwin E. Salpeter of Cornell University in 1952 to calculate the crucial fact that even though a Beryllium nucleus created by combining two Helium nuclei is unstable, under the extreme temperature and pressure conditions existing inside stars it lasts long enough to serve as the all-important stepping stone to the heavier elements. Before they have a chance to fly apart again, some of the Beryllium nuclei combine with a third Helium nucleus to form a stable Carbon nucleus. From then on, it is easy to add protons and neutrons one at a time to create the medium-weight elements like Nitrogen, Oxygen, Sodium, Phosphorous, Chlorine and others all the way up to Iron. These elements are slowly created over the multi-billion year lifetime of each star.

At Iron, however, the stellar element factory runs out of steam. No heavier elements can be created in the cores of stars. Another impasse. Only the violent explosion of a supernova can create the heaviest elements like Copper, Zinc, Silver, Tin, Lead, Gold, Mercury, and Uranium. These are created in only a few minutes at the end of the lifetime of all large stars.

We may view the creation of the elements as an unusual road to be traveled. It takes only a few bumpy minutes to travel from the beginning to Helium. There we meet a roadblock and have to detour via Beryllium to reach Carbon. From then on it's smooth sailing for a few billion years with lots of interesting stops on the way to Iron. After that, the road turns bumpy again and the stops get very frequent, but it's only a few minutes until we reach Uranium.

Since the heavier elements are necessary for life as we know it, it is evident that a lot of activity had to take place in the universe before life could arise. The Big Bang had to cool off. First generation stars had to be born, live out their lifetimes, and undergo an explosive death. Then second generation stars could be born out of the debris that contained the heavy elements. Only then could life finally arise.

The Fingerprints of Life

The sophisticated chemical experiments performed by the Viking Landers on Martian soil have not revealed any definite evidence of life. Perhaps the experiments were made too specific, suggest Amos Banin and Jerzy Navrot of Hebrew University in Israel.* (**Icarus*, vol. 37, p. 347, 1979)

It is difficult to define life-like characteristics in broad terms, and even more difficult to design sensitive experiments that are not very specific. The situation is loosely analogous to automatic differentiation between a footprint and a depression in the sand. And we don't even know what kind of creatures, if any, might be making footprints.

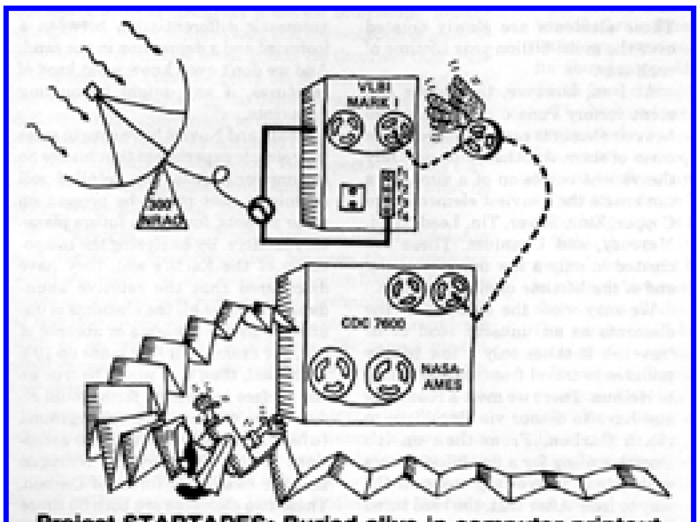
Banin and Navrot have sought some very simple experiment that makes no assumptions about the detailed soil chemistry that might be present on other planets, for use on future planetary landers. By analyzing the composition of the Earth's soil, they have discovered that the relative abundance of almost all the elements is unaffected by the presence or absence of life. For example, if Iron made up 10% of the soil, then that would be true on the surface (where life forms could affect it) as well as deep underground (where nothing lives). The sole exceptions to this discovery are Nitrogen and the oxidizable forms of Carbon. These two elements are both 50 times more abundant in life-bearing soil than elsewhere in the Earth's crust. Clearly, life forms must act to concentrate these elements.

Banin and Navrot suggest that the Viking Landers literally only scratched the surface of Mars, coming up only with the windblown dust that was sterilized by long exposure to extreme dryness and solar radiation in the atmosphere. Future landers should dig deeper to reach more protected and stable environments, and conduct simple but broadly powerful tests of the relative abundance of Nitrogen and oxidizable Carbon.

Project STARTAPES*

(*Presented at the International Scientific Radio Union (URSI) meeting in Boulder, Colo. (Jan. 1978), at the URSI meeting in Helsinki, Finland (August, 1978), and in a June, 1979, report of the University of California at Berkeley.)

A new program to search nearby stars for radio signals is being conducted by several National Aeronautics and Space Administration (NASA) scientists. STARTAPES stands for **S**tellar **T**argets **A**re **R**ecorded **T**o **A**cquire **P**otential **E**xtraterrestrial **S**ignals. Jill Tarter, Jeff Cuzzi, David Black, and Thomas Clark of NASA have used a special high-speed tape recorder to acquire data at a prodigious rate. The tape recorder is normally used to record very long baseline interferometry (VLBI) observations. An entire 2400-foot reel of magnetic tape is recorded in just three minutes, while a radio telescope tracks a chosen star. The tapes are then later analyzed using the very large CDC 7600 computer at NASA-Ames Research Center. The computer splits the recorded data up into 65,536 frequency channels, each having a bandwidth of 5.5 hertz. Four tapes are recorded for each star, each with the receiver tuned to a slightly different frequency, giving a total of 262,144 channels. The computer takes 30 times as much time to process the tapes as is required to record them in the first place, due to the massive amount of computation required. A large amount of computer output is generated, which takes a long time to sift through and analyze (see illustration).



Project STARTAPES: Buried alive in computer printout.

A total of 908 observations have been made so far, distributed over 201 nearby stars, using the 91-meter diameter radiotelescope at the National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia. Of these, 53 were found to contain unusual signals and were investigated further. Seventeen turned out to be random noise fluctuations, 15 were caused by equipment errors, and 20 were due to interference from terrestrial signals. This left only one unexplained signal. Unfortunately the observations were incomplete for that star, so it was not possible to eliminate terrestrial interference as the cause of this signal as well.

The NASA team plans further observations of that one star, as well as many others, using the 300-meter diameter radio telescope in Puerto Rico. The tape recording method has proven successful and valuable observational experience has been obtained. Eventually NASA will construct million or billion channel receivers and data processing systems to acquire and process this kind of data continuously in real time. Until then, STARTAPES is the next best thing, despite the drawback of short observational runs followed by long computer runs.

Using Radio Waves to Detect Gravity Waves

One method of detecting gravity waves is to use a large mass that resonates at the frequency of the gravity waves being sought (see ABCs of Space in the Winter 1980 issue of **COSMIC SEARCH**). An alternative method has been proposed by F. B. Estabrook of the Jet Propulsion Laboratory.* (*Presented at the Congress of the International Astronautical Federation in Dubrovnik, Yugoslavia, October, 1978.)

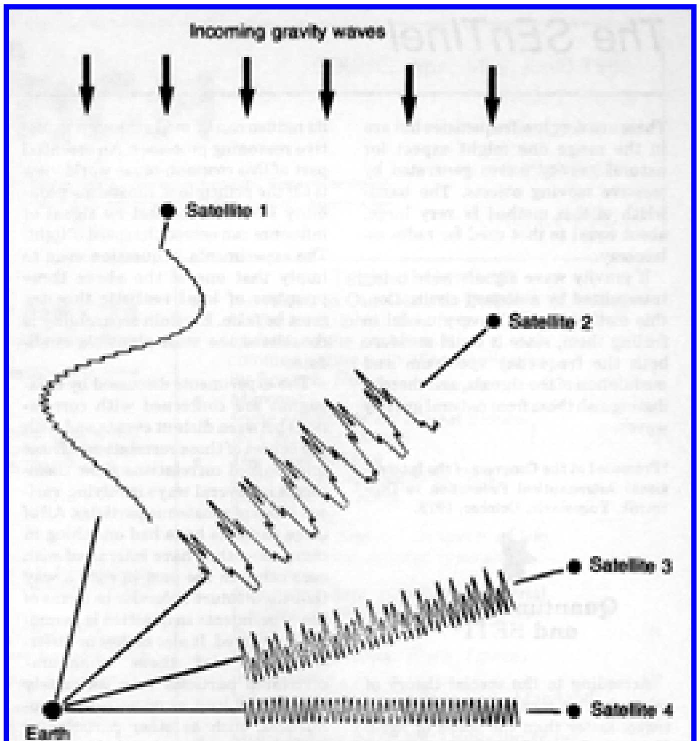
The method involves transmitting a radio signal from Earth to an interplanetary satellite, and using a repeater transmitter on the satellite to immediately retransmit the signal back to Earth, incurring a total round-trip delay of some time interval we may designate as *T*. The frequency of the radio signal used is immaterial, but *T* must be measured with utmost accuracy. If *T* is varying with time (implying that the satellite has a component of velocity toward or away from the Earth), the frequency of the returned radio signal will be changed (Doppler shifted) slightly. Since inter-planetary satellites are far away and move slowly, they change their velocity relative to Earth only very slowly. Thus, we can regard the Doppler shift caused by the motion of the satellite to be approximately constant with time.

If a passing gravity wave engulfs the Earth and the satellite, it will cause an *additional* Doppler shift to occur. The normally constant Doppler shift will exhibit sinusoidal fluctuations about its normal value. The motion-caused Doppler shift may be regarded as the "direct-current" or DC component and the gravity-wave-caused Doppler shift as the "alternating-current" or AC component. Another way of looking at it is to regard the motion-caused Doppler shift as analogous to a radio wave "carrier," and the gravity-wave-caused shift as a "frequency modulation". It is very important to understand, however, that the motion-caused Doppler shift must be present before a gravity wave can cause additional Doppler shift. This is analogous to the fact that a radio carrier must be present, in order for it to be frequency modulated.

The gravity wave Doppler shift has two different sinusoidal components. The higher frequency component occurs at the frequency of the gravity wave itself. Its amplitude is maximum when the radio wave is perpendicular to the gravity wave, and is zero when they are parallel. [1] ([1]The high frequency component is proportional to sin $(2\pi f_g T)$, where f_g is the frequency of the gravity wave.) The lower frequency component has a frequency that depends on the angle of intersection between the radio and gravity waves.[2] ([2]The low frequency component is proportional to $\sin(1-\cos\theta)2\pi f_g T$, where theta ($\theta$) is the angle between the direction of the two waves. In all cases, the amplitude of the extra Doppler shift is proportional to the strength of the gravity wave.) When the waves are perpendicular, the frequency is the same as the gravity wave and its amplitude is minimum. When the waves are parallel, the frequency is zero and the amplitude is maximum.

This latter case (which occurs when the satellite is in exactly the same or opposite direction to the gravity wave) is not useful, since a zero-frequency sinusoid whose initial value is zero will have a zero value for all finite times. Thus, gravity waves in those two directions cannot be detected by this method.

These effects are illustrated in the diagram. The gravity-wave-caused Doppler shift as a function of the delay time *T* is shown for four different satellites in various directions. The frequency of an incoming gravity wave can be determined from the high-frequency wiggles in the Doppler shift curve, and the arrival direction of the gravity wave can be determined from the low-frequency wiggles. Thus, the method is very general in application.



Gravitational wave detection system in which gravity waves modulate radio waves sent from the earth to moving probes or satellites and back again. The effect varies with direction being a maximum when the radio path is perpendicular to the gravity wave direction.

One of the practical difficulties in applying the method is that there are diffuse plasma clouds floating around in space, and when a satellite goes through or behind one, a Doppler shift is introduced which tends to mask that caused by gravity waves. This effect can be overcome by using two or more satellites simultaneously, since they could not all be influenced by the same plasma cloud. Another reason for having as many satellites as possible is that their Doppler waveforms can be intercompared and averaged to detect weaker signals, or to sort out gravity waves arriving from several different sources simultaneously.

The frequency range of gravity waves that can be detected by this method is limited by current technology to between 0.0001 and 0.1 hertz. These are very low frequencies but are in the range one might expect for natural gravity waves generated by massive moving objects. The bandwidth of this method is very large, about equal to that used for radio astronomy.

If gravity wave signals were being transmitted by a distant civilization, this method would be very useful in finding them, since it could measure both the frequency spectrum and modulation of the signals, and thereby distinguish them from natural gravity waves.

Quantum Theory and SETI*

(*Contributed by David Raub.)

According to the special theory of relativity, no signal or influence can travel faster than the speed of light. However, Bernard d'Espagnat writing in the November 1979 issue of *Scientific American* described a series of experiments in which this basic tenet of modern science seems to be violated. D'Espagnat explained that if certain subatomic particles are brought together by well-defined quantum mechanical procedures, they appear to exhibit influences on each other after they are separated again, with the influences occurring at superluminal (faster-than-light) speeds. In fact, five out of seven experiments conducted since 1972 point in the direction of this phenomenon.

Recent insights in the field of quantum physics seem to say that results derived from experiments conducted in a quantum mechanical context are in conflict with what d'Espagnat calls local realistic theories of nature.

In short, d'Espagnat's theories are basically "common-sense" viewpoints that (1) take the existence of an independent external reality for granted. This external reality, although independent of the observer, can be known through human sensory perceptions and (2) logical conclusions regarding its nature can be made through inductive reasoning processes. An essential part of this common-sense world view is (3) the principle of Einstein reparability which states that no signal or influence can exceed the speed of light. The experiments in question seem to imply that one of the above three premises of local realistic theories must be false. Einstein separability is considered the most plausible candidate.

The experiments discussed by d'Espagnat are concerned with correlations between distant events and with the causes of those correlations. These unexplained correlations show themselves in several ways involving various kinds of subatomic particles. All of these particles have had one thing in common — they have interacted with each other in the past in such a way that their future behavior in terms of the experiments in question is permanently altered. It also makes no difference how far these quantum-correlated particles may ultimately separate as long as no perturbing influences, such as other particles or radiation, are encountered along their paths.

In the preponderance of tests described by d'Espagnat, this past correlation relationship reveals itself in future experimental measurements as an influence which appears to occur instantaneously. In those cases where this "superluminal connection" did not appear, d'Espagnat attributed it to basic systemic flaws in the designs of the experiments themselves.

If future tests prove with certainty that this effect occurs instantaneously, does this mean that the principle of the finite propagation time of signals must be abandoned? According to d'Espagnat and most other physicists, the answer is no. In their view, these influences could not be utilized to transmit any useful information or signals, as can be done with electromagnetic radiation.

It should be noted, however, that this view is not unanimously held by all physicists. Dr. Jack Sarfatti, formerly of San Diego State University, and Dr. Nick Herbert, Director of the C-Life Institute in California, have both been working on theoretical schemes which purportedly could use these quantum correlated effects to transmit information instantaneously to any place in space and time regardless of distance. Although neither Sarfatti nor Herbert has achieved success thus far in these experiments, nor do they have much acceptance from the scientific community for attempting to prove the validity of their schemes, this controversy does show that the issue of superluminal propagation of information is not yet completely resolved.

If Sarfatti and Herbert prove to be correct in their revolutionary ideas, it would have a large impact on the Search for Intelligent Life in the Universe.

Bumper Science

I dig archeology

Astronomy is looking up

Astronomers follow heavenly bodies

Botany is leafing out

I nose my way around in chemistry

Cryogenics is real cool

Electronics gives me a charge

Geology is on the rocks

Mathematics is a numbers game

Get with the current, be an oceanographer

Meteorology is in the air

Physics is good for you

Space is far out

HOME

Designed by Jerry Ehman.
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