SETI LEAGUE ®

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Active Assessment of Active SETI

By H. Paul Shuch, Ph.D. Executive Director

Almost since its inception nearly half a century ago, SETI science has seen its supporters wage a running battle over the question of transmissions from Earth. Deliberate transmission of signals into space, sometimes called Active SETI, is justified by its proponents on the grounds of reciprocity. That is, some argue, we cannot in good conscience search for signals which we would hope other civilizations might choose to beam our way, if we ourselves are not willing to transmit such signals from Earth. The counter-argument involves the safety, and some would say the very survival, of our planet. Critics to Active SETI point out the dangers of shouting in the jungle. Radio amateurs in support of Active SETI counter that (1) the cat is already out of the bag, as we have been inadvertently transmitting to the stars for a century or so, and (2) if everybody's listening and nobody calls CQ, the bands will appear dead to all concerned.

Eloquent arguments on both sides of the issue have appeared in the pages of *SearchLites*, and on The SETI League's website, since our organization was founded more than a decade ago. They reflect a very real concern on the part of parties subscribing to two diverging philosophies, but I find it interesting that the argument itself evidences a significant agreement: all seem to accept as a given the existence of technological civilizations beyond Earth. The existence of ETI would appear no longer open to question; only its intensions are a subject of debate.

Recently, the arguments about the advisability of transmitting from Earth have led to renewed efforts to establish international transmission protocols. Predictably, there are those who would urge no policy restrictions against free flow of information to the stars, and others who would restrict transmission from Earth, or at least subject it to political scrutiny prior to deeming it acceptable. The problem with such discussions is that, regardless of the side of the issue a given person takes, the parties seem to desire a blanket and inflexible policy, one that fails to consider the merits and risks of transmissions on an individual basis.

But, despite the language of any constitution, not all transmissions are created equal! The benefits and risk of a given interstellar transmission are related to its power relative to the electromagnetic background, to its duration, its directionality, its bandwidth, and its information content. Even the most cautious critic of Active SETI will recognize that some transmissions are so unlikely ever to be detected that their potential impact (be it for good or for ill) is negligible. Other transmission scenarios can be envisioned which would so mark Earth as an aggressive and inconsiderate planet as to alarm even the staunchest proponent of Active SETI. So, any blanket policy (either for or against transmission) which fails to distinguish between signals is missing an important point.

Is it not possible to evaluate individual Active SETI proposals in terms of their potential impact, perhaps quantifying each on some sort of objective scale? Our Hungarian friend and colleague Ivan Almar thinks so, and last Spring he proposed, at a SETI conference in San Marino, a new analytical tool to do just that. Now called the San Marino Scale, Dr. Almar's proposal has been discussed and refined (but not yet adopted) by the SETI Permanent Study Group of the International Academy of Astronautics, on which several SETI League members serve. It would quantify on an integer scale of 1 to 10, based upon specific, measurable characteristics, the transmission risk associated with any Active SETI project, historical or proposed, or for that matter any other transmission of electromagnetic energy from Earth. The San Marino Scale is described at some length on that Study Group's website, http://iaaseti.org (from the main menu at the left of each page, click on "Protocols;" then scroll down the page and look for the San Marino Scale link).

I urge all SETI League members to familiarize themselves with this new analytical tool. Whether promoting transmissions, or arguing for international sanctions, let us do the quantifiable risk/benefit analysis for which engineers are noted. A transmission with a San Marino score of 1 ('insignificant') through 3 ('minor'), I would suggest, scarcely warrants scrutiny. An impact score of 8 ('far-reaching') through 10 ('extraordinary'), on the other hand, should give even the most ardent Active SETI supporter pause. ❖

About SETI Range and Sensitivity

by Lieven Philips

In this short paper I would like to make an additional comment on the discussion of the achievable range of the Arecibo radio telescope, in *SearchLites* Vol. 11, No 3 (Summer 2005).

When Arecibo is mapping the hydrogen distribution in the Milky Way, then the radio telescope's receiver is piling up energy in a relatively narrow band centered around a certain frequency. Only the *energy* of the signal is important; there's no phase information recovered (it doesn't make sense). When Arecibo was receiving the beacon signal from Pioneer 10, it was also about recovery of *energy* in a very narrow band. But when there is data communication with a space probe (e.g. compressed images from Cassini-Huygens) then recovery of the data involves data demodulation, and data demodulation implies *coherent tracking*, i.e. carrier phase recovery (for a PSK signal). The range that can be achieved depends on the transmission power and the bandwidth. We can increase the range by reducing the data rate (which determines the bandwidth), at constant transmission power.

In most SETI searches, we are looking for very narrowband (CW) signals, which we try to detect with multi-million points FFT's. The accumulation of energy in each frequency bin (each possible channel) is performed over a certain limited time (say 100 seconds), in order to average out fluctuations of the noise power. The time interval is limited because Doppler effects and interstellar scintillation (fading) gradually influence the frequency and the amplitude of the signal. Instead of accumulating *energy*, however, we could also attempt - in principle - to *track* the CW ETI beacon over an extended duration. If this was possible, then we could detect CW signals which are deeply buried in the noise, because the coherent FFT gain is proportional to the tracking interval (i.e. the duration of the coherent correlation). This means that - if it was possible to track the CW signal - we could extend the recovery range far beyond the typical range non-coherent energy detection or modulated signals.

Of course it is not possible to actually track the CW signal, because we cannot phase synchronize to it (because the CW signal is assumed to be buried in the noise). But what we can do is to run a vast amount of *hypotheses on the phase evolution* on our interval (of say 1 hour duration). These hypotheses are similar to the Doppler compensation hypotheses that are applied e.g. in SETI@home. This leads to an explosion of calculations, but at the benefit of significantly extending the range. Moore's law and advances in grid computing would eventually allow this to be a practical approach.

Example:

Consider a 5 kHz wide frequency bin with a sine waveform (CW signal) at 1500 kHz at power = 1, accumulated on a noise signal (random variable) with variance = 36. This is hence a signal deeply buried in the noise. **Figure 1** shows the signal, **Figure 2** the signal in the noise. Now we perform FFT's with different lengths: **Figure 3** shows the spectrum resulting from a 512-points FFT. The signal is not detected. **Figure 4** shows the spectral analysis at an 8 times longer time interval, using a 4096-points FFT: the signal is present, but parasitic noise peaks prevent clear discrimination. With 8192 points (**Figure 5**), the FFT results in a high S/N ratio. This means that with a sufficiently long time window (i.e. FFT length) when can detect every CW signal, no matter how weak it is. All figures obtained using Matlab.

This reasoning is not in contradiction with what we normally understand as sensitivity, or with what the Shannon theorem tells us. Sensitivity is typically defined as the signal level above noise that is still detectable by a receiver. However, with the coherent detection we can go arbitrary far below the noise + interference floor, because we have defined our level of detectability not in function of a telecommunications link, but only in function of the detectability of the presence of a signal, not the signal content. Similarly, there is no violation of the Shannon theorem: we can consider the narrowband CW signal as a single bit, smeared out infinitely, over a very narrow bandwidth; as a consequence, the S/N can go arbitrarily low, or the range can be arbitrarily extended, at the expense of computation time.

In principle, this kind of search would be applicable to check out globular clusters or galaxies. The gigantic amount of computation would be compensated by the number of stars that can be scrutinized simultaneously: it is sufficient that one civilization on one planet of one star in the Andromeda Galaxy has detected a life bearing planet in our Galaxy (e.g. spectroscopically), and decided to install an eternal beacon directed to us. This search strategy would comply with the hypothesis from Cohen and Hohlfeld (*Sky and Telescope*) that life in the universe is quite rare, and hence we have to search for a beacon which is "very powerful, but very far away".

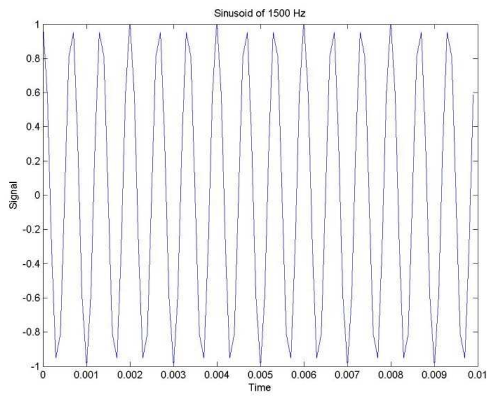

Figure 1

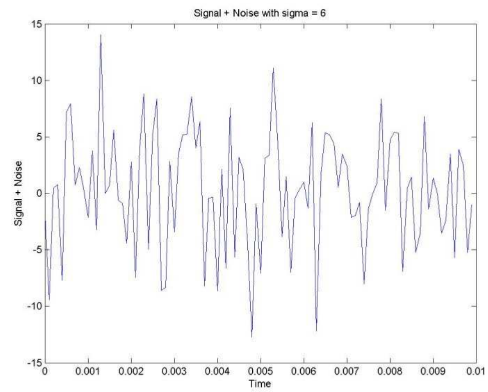

Figure 2

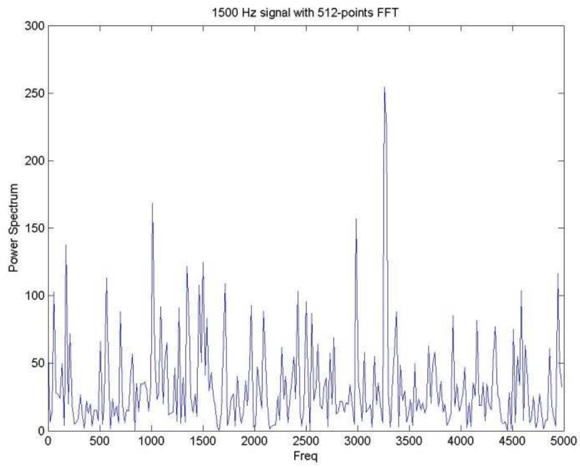

Figure 3

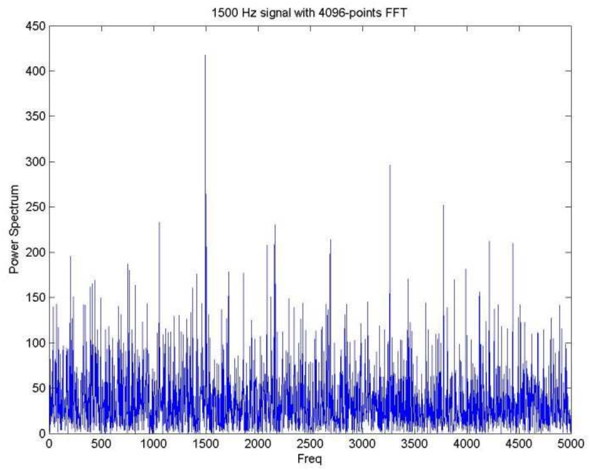

Figure 4

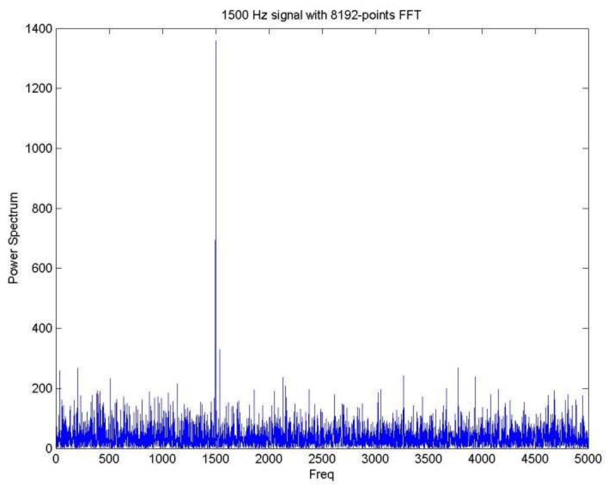

Figure 5

Event Horizon

SearchLites' readers are apprised of the following conferences and meetings at which SETI-related information will be presented. League members are invited to check our World Wide Web site (www.setileague.org) under *Event Horizon*, or email to us at info@setileague.org, to obtain further details. Members are also encouraged to send in information about upcoming events of which we may be unaware.

December 9 - 11, 2005: *Philcon 2005*, Philadelphia PA.
April 22, 2006, 0000 UTC - 2359 UTC: Eighth annual SETI League Ham Radio QSO Party, 14.204, 21.306, and 28.408 MHz.
April 30, 2006: Twelfth SETI League Annual Membership Meeting, SETI League Headquarters, Little Ferry NJ.
May 19 - 21, 2006: Hamvention 2006, Dayton OH.
June 18 - 21, 2006: *SETICon06 Technical Symposium*, in conjunction with *Society of Amateur Radio Astronomers* Conference, NRAO Green Bank WV.
July 27 - 30, 2006: *Central States VHF Conference*, Minneapolis MN.
August 23 - 27, 2006: *L.A.Con IV* World Science Fiction Convention, Los Angeles, CA.
August 25 - 27, 2006: *EME Conference 2006*, Wuerzburg Germany.
September 8 - 10, 2006: EuroSETI06, in conjunction with the Fourth International Congress for Radio Astronomy, Heideburg Germany.
October 2 - 6, 2006: *57th International Astronautical Congress*, Valencia Spain.
October 6 - 8, 2006: *AMSAT Space Symposium*, San Francisco CA.
April 21, 2007, 0000 UTC - 2359 UTC: Eighth annual SETI League Ham Radio QSO Party, 14.204, 21.306, and 28.408 MHz.
May 18 - 20, 2007: Hamvention 2007, Dayton OH.
June 2007 (dates TBA): *Society of Amateur Radio Astronomers* Conference, NRAO Green Bank WV.
July 26 - 29, 2007: *Central States VHF Conference*, San Antonio TX.
August 30 - September 3, 2007: *65th World Science Fiction Convention*, Yokohama Japan.
September 24 - 28, 2007: *58th International Astronautical Congress*, New Delhi, India.
September 30 - October 4, 2008 (proposed): *59th International Astronautical Congress*, Glasgow, Scotland.

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How Old is ET?

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ABSTRACT

This paper considers the factors that determine the probable age of a civilisation that might be detected in a SETI search. Simple stellar evolution considerations suggest an age of a few Gyr. Supernovae and Gamma-ray-bursters could in principle shorten the lifetime of a civilisation, but the fact that life on Earth has survived for at least 4 Gyr places a severe constraint on such factors. If a civilisation is detected as a result of a SETI search, it is likely to be of order 1 Gyr more advanced than us.

1. INTRODUCTION

When we conduct searches for extra-terrestrial intelligence, we often make implicit assumptions about the age of the civilisation that we are trying to find. For example, our strategy for searching for a life-form of a similar age to us is likely to be different from that for a civilisation billions of years more advanced than us. Similarly, in the event of a confirmed detection, the way in which we plan our response will also depend on how advanced that civilisation may be. In this paper, I estimate the likely age of the civilisation that we are most likely to detect, should we be successful in our searches.

The two key factors that determine how old a detected civilisation is likely to be are (a) the length of time since intelligent life first appeared in our Galaxy and (b) the median lifetime of a civilisation. The second of these is more problematic, since the development of a civilisation can be cut short by a wide range of events, including disease, war, global mismanagement, asteroids, supernovae, and gamma-ray bursters. We should also acknowledge the possible existence of other hazards, of which we are not yet aware. For example, the devastating effect of gamma-ray busters has only been appreciated in the last 2-3 years, and there are probably other phenomena yet to be discovered. Events such as disease, war, and global mismanagement are almost impossible to quantify, and so in this paper I concentrate on those events that we can quantify: asteroids, supernovae, and gamma-ray bursters. But in the first section of this paper, I consider what the maximum lifetime of a planetary-bound civilisation might be.

Throughout this paper, I make a very conservative assumption that an extraterrestrial civilisation (ET) resembles us in most significant respects (other than age and evolution). In other words, ET lives on a planet orbiting a solar-type star, and has taken as long after the formation of their star to evolve to "civilisation" as we have, which is ~5 Gyr (Gigayears, or billion years). I therefore estimate the longevity of ET by looking at the hazards that confront the Earth.

2. THE NATURAL LIFETIME OF A CIVILISATION

I assume that stars like our Sun have been forming since the formation of the Galaxy some 10 Gyr ago. Observed changes in metallicity since then are not sufficient to alter this simple assumption significantly. Our Sun is now about 5 Gyr old, and has an expected total lifetime of 10 Gyr.

For the first 5 Gyr of the life of the Galaxy, there would not have been enough time for a civilisation to develop, and so ET did not exist. Between 5 and 10 Gyr, assuming a constant rate of star formation, the number of civilisations would increase linearly until the present day. At around the present time, some of those first solar-type stars will be dying at the same rate as others are forming, and so, assuming their civilisations die at the same rate as they do, the number of civilisations is then level from now on.

The median age of a civilisation is therefore the median age of those civilisations that started between 5 and 0 Gyr ago, which is 1.7 Gyr. Therefore, in the absence of other factors, any civilisation that we detect via SETI is likely to be 1.7 Gyr more advanced than we are.

3. THE EFFECT OF SUPERNOVAE

A supernova results from the explosion of a high-mass star after its hydrogen and helium fuels are used up, at the end of its lifetime. A supernova exploding within 50 ly of the Earth will have a catastrophic effect. The 10^{40} J of energy produced in the first few days bathes the earth in a total amount of ionisation some 300 times greater than the annual amount of ionisation from cosmic rays. Surprisingly, little of this radiation reaches Earth. Instead, Most of it ionises atmospheric nitrogen, which reacts with oxygen to form nitrous oxide, which in turn reacts with ozone [3]. The effect will be to reduce the amount of ozone in the Earth's atmosphere by about 95%, resulting in a level of UV on the Earth's surface some four orders of magnitude greater than normal, which continues for a period of 2 years. This will certainly result in almost 100% mortality of small organisms and most plants. The effect on mammals is not clear, and some might survive. However this 2-year period is followed by a longer (80 years) period of bombardment by the cosmic rays from the supernova, which have similar, although slightly reduced, effects. It is difficult to see how anything other than an advanced civilisation could survive such an extended holocaust.

A supernova such as this goes off in our galaxy roughly every 5 years, and we expect one within 50 ly (light-years) of the earth roughly once every 5 Myr. We expect one even closer (within 10 ly) every 200 Myr. Therefore all life would be expected to be destroyed at this interval. Clearly this has not happened, since we are still here, and I will return to possible reasons in a later section.

4. THE EFFECT OF GAMMA-RAY-BURSTERS

Gamma-ray bursters (GRB) are a recently discovered phenomenon, in which some 10^{45} J of energy are released in a few seconds. The ones that have been observed on earth appear to be distributed uniformly across the observable Universe. Their power is such that we are able to detect GRB right up to the edge of the observable universe. The mechanism is still not known, but is likely to involve the merging of two neutron stars, possibly resulting in the formation of a black hole.

A GRB is some 5 orders of magnitude more energetic than a supernova, and could occur even at the Galactic centre, 25 000 ly away from us, and have a similar effect as a supernova within 50 ly. However, in this case there is an even more deadly effect, in that, should a GRB go off in the Galactic centre, the immediate blast of ionising radiation is followed by an intense blast of cosmic rays lasting perhaps a few weeks [4]. These cosmic rays will initiate a shower of relativistic muons in the Earth's atmosphere, causing a radiation level on the surface of the earth some 100 times greater than the lethal dose for a human being. The muons are so energetic that they would even penetrate nuclear air-raid shelters to a depth of perhaps hundreds of metres [2].

We expect such a GRB roughly once every 200 Myr, and it would almost certainly result in the extinction of all life on earth other than that deep in the ocean. Again, clearly this has not happened, since we are here.

5. MASS EXTINCTIONS ON EARTH

The geological and biological record shows a series of mass extinctions of life on Earth. The most famous is that at the Cretaceous-Tertiary (KT) boundary, which was almost certainly caused by an asteroid hitting the earth about 65 Myr ago. The KT mass extinction wiped out the dinosaurs, and paved the way for the emergence of mammals as the dominant species on Earth.

Less well known are a series of similar, and in some cases even more extreme, mass extinctions every few tens of Myr, and many smaller extinctions, the last of which was only 11000 yr ago. The cause of most of these is unknown. It is likely that a range of causes including asteroids, distant supernovae, and climatic changes are responsible for them.

All these mass extinctions are on a much smaller scale than the catastrophic events we expect from a nearby supernova or a gamma-ray burst in the Galactic centre. In each of these cases, a number of species (sometimes as many as 50%) were extinguished, but a sufficient range of diversity remained for the biota to recover in a relatively short time.

6. WHY ARE WE HERE?

I have identified two causes that should wipe out essentially all life on Earth roughly every 200 Myr, and yet we are here. Two possible explanations are:

- The calculation of either the timescales or the severity of the effects is erroneous, or
- We have been very lucky!

In the first case, simply multiplying the timescale by a factor of a few is insufficient. We have been evolving for at least 4 Gyr, and so the interval between catastrophes must be at least 4 Gyr for us to survive so far. Presumably the precise interval will vary randomly around this figure, and so any surviving civilisation can look forward to a lifetime of between zero and a few Gyr. In this case, if we detect ET, then ET will have a median age of perhaps 1 or 2 Gyr, which is similar to the 1.7 Gyr derived from simple stellar evolution arguments. Thus, in this case, the supernovae and GRBs have not significantly changed the median age of ET.

In the second case, we have already survived for some 20 times the mean interval between catastrophes, which is very lucky indeed. Whilst it is not possible to quantify this without more detailed knowledge of the frequency distribution of supernovae and GRB, it is likely that the probability is so low that we are alone in the Galaxy. Apart from providing a solution to the Fermi paradox [1], this implies that the median lifetime of ET is meaningless, as we will never detect ET!

7. CONCLUSION

Conventional models imply that supernovae and gamma-ray-bursters will extinguish life on planets at intervals of about 200 Myr. Since this has not happened on Earth, either these conventional models are wrong, or else life on Earth is probably unique in the Galaxy. The first case predicts a median age of ET as being of the order of 1 billion years. The second case predicts that we will never detect ET. Thus, if we do detect ET, the median age is of order 1 billion years. Note that, in this case, the probability of ET being less than one million years older than us is less than 1 part in 1000.

Therefore, any successful SETI detection will have detected a civilisation almost certainly at least a million years older than ours, and more probably of order a billion years older.

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Ask Dr. SETI:

Where Should I Point My Dish?

Dear Dr. SETI:

I am setting up my Project Argus station. I have some problems, because my backyard is a bit small, and I will have trouble rotating my 2.45 meter dish in some directions. Which is better, to have a smaller dish that I can move to track celestial objects, or a larger one, fixed in position? Also, if I put the larger antenna in a fixed position, what is the best azimuth and elevation position for drift-scan mode?

Iban (Spain)

The Doctor Responds:

Almost all of our members opt for a larger dish, Iban, and generally operate successfully in meridian transit (drift-scan) mode. Many simply point the dish straight up ("bird bath" mode). As long as there are stars in the general direction of "up", then this is as reasonable a strategy for all-sky surveys as any other.

For any fixed antenna, I believe the best azimuth to use is 0 or 180 degrees true, because this will give you meridian scan. That is, your Local Mean Sidereal Time will be equal to Right Ascension, which simplifies all astronomical calculations.

As for elevation, most of our members just point straight up, 90 degrees from the horizon, which sets their declination equal to their latitude. In addition to simplifying the mathematics, this has the added advantage of minimizing wind loading on the antenna. But you can really use whatever elevation is convenient, that will keep your antenna clear of obstructions.

Remember, there are no wrong directions for SETI, except "down", which might be your choice for SSTI (Search for Sub-Terranean Intelligence)!

Justifying Janskys

by Roy Norris, Birmingham AL
(Argus Station EM34ts)

When specifying the strength of an electromagnetic wave received from a non-terrestrial source, a variety of units are used depending on the nature of the source and the nature of the receiving device. The strength of the received signal is of significant interest since it determines the required gain of the antenna (hence it's size) and the amount of amplification that will be required in the receiver in order to make the signal audible or recordable.

In most traditional SETI applications, a weak, narrow bandwidth signal is generally the sought after target because an artificially generated electromagnetic wave can be most efficiently generated and detected when the bandwidth of the signal is narrow. All of the energy of the wave is contained within a narrow band of frequencies, referred to as signal bandwidth. But unfortunately, all signals are also accompanied by noise. Since the signal's energy is contained in a narrow bandwidth frequency range, we can reject much of the accompanying noise by the use of narrow bandwidth filters on the receiving end which are just wide enough to pass the signal energy but reject most of the noise energy. We thereby dramatically improve the delectability of a weak signal because delectability is ultimately dependent on the ratio of the signal to the noise; the higher the ratio, the more easily the signal is detected.

On the other hand, most natural astronomical radio sources such as active radio galaxies, pulsars, the 3 degree K microwave background radiation, and synchrotron radiation from our own galaxy radiate electromagnetic waves over a very wide band of frequencies, by nature, often extending over many thousands of megahertz. Such sources are often referred to as "continuum sources". Radio astronomers intent on capturing the weakest of these signals, therefore use extremely wideband receivers and antennas in order to capture as much of the signal power as possible, which is dispersed over a wide bandwidth of frequencies.

These two fundamentally different requirements, the detection of narrow band width signals for the SETI scientist and the detection of wide bandwidth continuum sources for radio astronomers lend themselves to two different methods of specifying signal strength, also called flux density, each uniquely suited to the nature of the received signal. For narrowband signals of greatest interest to SETI, signal strength is specified in watts/square meter. For wideband continuum signals of interest to radio astronomers signal strength is specified in watts per square meter per hertz.

In both cases, the actual signal power available to the receiver to be amplified and recorded is dependent upon the capture area of the antenna. Just as in a rainfall, a bigger bucket (more capture area) traps more raindrops, the larger the capture area of the antenna, the more signal power it captures as well.

But in the case of the radio astronomer's wide band continuum signal, another factor must be taken into consideration. Since the signal power is distributed over a wide band of frequencies, we cannot hope to capture all of it since no practical receiver is sensitive over the enormous frequency range characteristic of continuum signals. Hence the radio astronomer constructs his/her receiver to capture a limited but as wide a band of frequencies as is feasible. Therefore, the radio astronomer must allow for the portion of the continuum radiation he is able to capture which is determined not only by the capture area of the antenna but also by the bandwidth of his/her receiver. The broader the bandwidth, the greater the signal power captured.

Radio astronomers have formalized a unit called the **Jansky** to express signal strength for continuum signals:

$$\textbf{1 Jansky} = \mathbf{1 \times 10^{-26}} \; \frac{\textbf{Watts}}{\textbf{Meter}^2 \textbf{ Hertz}}$$

So, to determine the theoretical received signal power, one simply multiplies the signal strength in **Jansky** of the source by the capture area of the antenna in square meters and by the receiver bandwidth in Hertz with the result expressed in **Watts.**

In the case of the sought after SETI signal, the radiated power from an artificial extraterrestrial source is expected to be of narrow bandwidth for maximum efficiency and delectability; perhaps as narrow as 1/100 of a **Hertz**. No increase in received signal power is gained by listening to a wider band of frequencies than that of the expected signal. Listening to bandwidths wider than the expected signal only increases the amount of noise which is received, deteriorating the signal to noise ration and making detection more difficult. Since its assumed that the receiver captures the full power of the signal within its narrow bandwidth, signal strength need only be specified in $\frac{\textbf{Watts}}{\textbf{Meter}^2}$.

So, to determine the theoretical received signal power of a narrowband SETI signal we simply multiply the signal strength in watts/meter^2 by the capture area of the antenna with the results expressed in **Watts.**

The **Watt** is the basic unit for expressing power, as in 100 watt light bulbs and other commonly encountered sources or expenders of power. But the **Watt** is a very large unit for power when dealing with signals that may have traveled over many light years of space to reach us. Even the **milliwatt** (1/1000 of a Watt) is far too large for these purposes. Communications engineers long ago developed a way of expressing very low levels of power by relating it to 1 **milliwatt** using a logarithmic scale so the numbers did not get too large. This unit is the **dBm**. It is defined as follows:

$$\textbf{Power (in dBm)} = \mathbf{10 \times Log} \; \frac{\textbf{Power (in Watts)}}{\textbf{.001 Watt}}$$

Note that for power levels less than 1 **milliwatt**, the power in **dBm** will carry a negative sign. For powers above the level of 1 **milliwatt**, the power in **dBm** will carry a positive sign. Don't get confused into thinking these are positive and negative powers. The negative sign is just the result of the use of a logarithmic scale and how we express decimal fractions in terms of exponents. These calculations can be easily performed on a simple scientific calculator which will keep the pluses and minuses straight for you.

Are there occasions when SETI participants will want to use Jansky units ? Well, not in conjunction with narrow band signals but there are occasions when they may be useful. For example you might wish to test or calibrate the sensitivity of your SETI receiving station using an astronomical source. Most astronomical sources have their signal strengths listed in Jansky units in various catalogs of astronomical radio sources. These can be very useful in measuring the sensitivity of our SETI stations.

As a typical example, lets say I have a 10 foot parabolic dish antenna and I point it at a continuum radio source listed in the catalog as having a signal strength of 25 **Jansky** at the frequency I am interested in observing and I am just able to detect it. What is the power level in **dBm** presented to the receiver by the antenna and hence a measure of the sensitivity of my SETI station? For the purpose of this exercise I will use the widest bandwidth my receiver is capable of to maximize the power I capture from the signal, say 1 **MHz.**

The Givens:
25 Jansky signal strength
10 foot diameter parabolic dish antenna
Assume 50% antenna aperture efficiency
1 MHz receiver bandwidth.

Theoretical Antenna Capture Area

$$= AR^2 = 3.1416 \times (5)^2 = 78.54 \text{ feet}^2$$

$$= 78.54 \text{ feet}^2 \times 0.0929 \frac{\text{meters}^2}{\text{feet}^2} = 7.30 \text{ meters}^2$$

Effective Antenna Capture Area

$$= 0.5 \times \text{Theoretical Capture Area} = 3.65 \text{ meters}^2$$

Power Level to the Receiver

= Signal Strength X Eff Ant Capt Area X Rcvr Bandwidth

$$= 25 \times 10^{-26} \frac{\text{Watts}}{\text{meter}^2 \text{ Hz}} \times 3.65 \text{ meters}^2 \times 1 \times 10^6 \text{ Hz}$$

$$= 9.125 \times 10^{-19} \text{ Watts}$$

Converting Watts to dBm:

Power Level to the Receiver

$$= 10 \times \text{Log} \frac{9.125 \times 10^{-19} \text{ Watts}}{0.01 \text{ Watts}} = -150.4 \text{ dBm}$$

Hence, my SETI station can detect signals as weak as -150.4 **dBm** which is very good performance.

You can also use calculations similar to these to determine how large an antenna and how much gain will be required in your receiver/preamplifier system in order to detect a given signal strength. However, in these cases remember to allow for feed line losses, mixer losses, and filter insertion losses which must be offset with additional amplifier or antenna gain. Also, the effects of internally generated noise plays a major role, but that's another story. ❖

SETI League Wins Twice in Bird Charity Auction

LITTLE FERRY, NJ.., 14 September 2005 -- The SETI League, Inc., grassroots leader in the privatized Search for Extra-Terrestrial Intelligence, has received both a unique piece of electronics equipment and a substantial cash contribution, in an unusual charity auction sponsored by a leading manufacturer of electronics test equipment.

Bird ® Electronic Corporation of Solon, OH.(a division of Bird Technologies Group), has reached the 300,000 unit mark on the production of its Model 43 Thruline® Wattmeter. In production since 1952, this instrument has become the industry standard for radio frequency (RF) power measurement. To commemorate this milestone, meter number 300,000 was manufactured with a special gold-plated finish. The company then decided to auction off this unique piece of electronics industry history, with the cash amount of the winning bid being contributed to the charity of the successful bidder's choosing.

The auction closed on August 31, 2005, with the winning bidder naming The SETI League as his designated charity. Thus, The SETI League has received a check for the bid price. Then, in a move that surprised and pleased SETI League officials, the anonymous donor contributed the milestone meter itself to the nonprofit science group. "We will use this impressive piece of test equipment to monitor the operation of our Lunar Reflective Calibration Beacon, which bounces microwave signals off the surface of the Moon, to be received by radio astronomy facilities around the world," stated SETI League executive director Dr. H. Paul Shuch.

Bird® Technologies Group provides technology solutions for semiconductor, public safety, wireless, broadcast, government, and military applications. Since 1942, they have provided comprehensive RF equipment diagnostic and testing solutions. With a worldwide network of partners, Bird offers the latest technology and most reliable customer care to all of the markets they serve.

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Director (Patron membership plus seat on advisory board)	$100,000
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Annual memberships are issued for the calendar year. Those processed in January through April expire on 31 December of that year. Those processed in September through December expire on 31 December of the *following* year. Those members joining in May through August should remit half the annual dues indicated, and will expire on 31 December of the same year.

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The SETI League invites you to pay your membership dues and additional contributions via Visa or MasterCard. Please fill out the form below and return it with any order. We thank you for your ongoing support.

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