



SearchLites

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The Quarterly Newsletter of The SETI League, Inc.

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Future Funding for the Arecibo Radio Observatory

by Nickolaus Leggett, N3NL

Editor's Note: Mr. Leggett has submitted this letter to the National Science Foundation. It is reproduced here by his kind permission.

I have read in *Sky and Telescope Magazine* (February 2007) and then in your own online report that the National Science Foundation is recommending that funding for the Arecibo Radio Observatory be dropped.

This would be a giant loss for American science and technology because the huge collection area of the Arecibo dish allows it to accomplish the following missions:

1. High-resolution and multi-spectral radar astronomy of the planets and non-planet objects within the solar system.
2. Detailed SETI surveys (such a listening survey is being conducted at the Observatory now on a "piggyback" basis along with other observations).
3. Communications experiments with Moon-bounce communications activity including two-way contacts with amateur radio operators and the monitoring of emergency beacon frequencies via an Earth-Moon-Earth path. (The latter monitoring would allow detection of emergencies at sea over the horizon.)
4. Passive monitoring and radar examination of high-orbit and deeper-space payloads by the United States Air Force, National Security Agency, and/or Central Intelligence Agency.
5. Graduate (and undergraduate) research projects in radio astronomy, atmospheric sciences, and communications.
6. Active experimentation with the microwave transmission of useful power from the Earth to space payloads. Later, useful reception of microwave power from a space installation by means of a rectifying antenna (rectenna) mounted at the telescope's prime focus.
7. Active transmission of SETI communications attempts under international control and direction. (Transmission of signal packets to likely categories of stars.)

A combined set of missions such as this can be conducted by appropriate scheduling of the telescope's time. In some cases, compatible missions can be conducted simultaneously.

The NSF should work to make sure that this excellent instrument remains in active service. ❖

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.

June 1 - 3, 2007: *Rochester Hamfest*, Rochester NY.

June 3 - 8, 2007: *Rutgers Symposium on Lunar Settlements*, New Brunswick NJ.

July 1 - 3, 2007: *Society of Amateur Radio Astronomers Conference*, NRAO Green Bank WV.

July 16 - 20, 2007: *Bioastronomy 2007*, San Juan PR.

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*, Hyderabad, India.

September 28 - 29, 2007: *Pacific Northwest VHF Society Annual Conference*, Bend OR.

October 18 - 20, 2007: *Microwave Update 2007*, King of Prussia, PA.

October 26 - 28, 2007: *AMSAT Space Symposium*, Pittsburgh, PA.

November 16 - 18, 2007: *Philcon 2007*, Philadelphia PA.

April 19, 2008, 0000 UTC - 2359 UTC: Eighth annual SETI League *Ham Radio QSO Party*, 14.204, 21.306, and 28.408 MHz.

May 16 - 18, 2008: *Hamvention 2008*, Dayton OH.

May 30 - June 1, 2008: *Rochester Hamfest*, Rochester NY.

June 2008 (dates TBA): *Society of Amateur Radio Astronomers Conference*, NRAO Green Bank WV.

July 24 - 27, 2008 (Tentative): *Central States VHF Conference*, Wichita KS.

Mid August 2008 (dates TBA): *EME 2008*, Florence Italy.

September 29 - October 3, 2008: *59th International Astronautical Congress*, Glasgow, Scotland.

October 2008 (proposed - dates TBA): *AMSAT Space Symposium*, Orlando, FL.

April 18, 2009, 0000 UTC - 2359 UTC: Tenth annual SETI League *Ham Radio QSO Party*, 14.204, 21.306, and 28.408 MHz.

May 15 - 17, 2009: *Hamvention 2009*, Dayton OH.

May 29 - 31, 2009: *Rochester Hamfest*, Rochester NY.

June 2009 (dates TBA): *Society of Amateur Radio Astronomers Conference*, NRAO Green Bank WV.

October 2009 (dates TBA): *60th International Astronautical Congress*, Daejeon, Korea.

October 2009 (proposed - dates TBA): *AMSAT Space Symposium*, Atlanta, GA.

April 17, 2010, 0000 UTC - 2359 UTC: Eleventh annual SETI League *Ham Radio QSO Party*, 14.204, 21.306, and 28.408 MHz.

June 4 - 6, 2010: *Rochester Hamfest*, Rochester NY.

June 2010 (dates TBA): *Society of Amateur Radio Astronomers Conference*, NRAO Green Bank WV. ❖

Shrinking the Tools

by Paul Gilster, gilster@centauri-dreams.org

Shrinking our instrumentation is one of the great hopes for extending spacecraft missions into the Kuiper Belt and beyond. No matter what kind of propulsion system we're talking about, lower payload weight gets us more bang for the buck. That's why a new imaging system out of Rochester Institute of Technology catches my eye. It will capture images better than anything we can fly today, working at wavelengths from ultraviolet to mid-infrared.

It also uses a good deal less power, but here's the real kicker: The new system shrinks the required hardware on a planetary mission from the size of a crate down to a chip no bigger than your thumb. The creation of Zeljko Ignjatovic and team (University of Rochester), the detector uses an analog-to-digital converter at each pixel. "Previous attempts to do this on-pixel conversion have required far too many transistors, leaving too little area to collect light," said Ignjatovic. "First tests on the chip show that it uses 50 times less power than the industry's current best, which is especially helpful on deep-space missions where energy is precious."

Precious indeed. But imagine the benefits of carrying miniaturization still further. Nanotechnology pioneer Robert Freitas has speculated provocatively about space probes shrunk from the bulk of a Galileo or Cassini into a housing no larger than a sewing needle. Launched by the thousands to nearby stars, such probes could turn their enclosed nano-scale assemblers loose on the soil of asteroids or moons in the destination system. They could build a macro-scale research station, working from the molecular level up to create tools for continuing investigation and communicating data back to Earth.

The new sensor out of Rochester is a long way from that kind of miniaturization, but surely the dramatic changes in computing over the past few decades have shown us how potent shrinking our tools - and packing more and more capability into them - can be. And when you're working with finite payload weight and can insert a new set of tools because they're smaller than before, you've dramatically extended what a given space mission can accomplish. Getting a millimeter-wide needle to Alpha Centauri may not be Star Trek, but it could be how we start.

This article first appeared on the Centauri Dreams website (www.centauri-dreams.org), and is used here by the kind permission of the author. ❖

Guest Editorial:

Where the Real DX Is

by Paul Gilster, gilster@centauri-dreams.org

Back in the 1980s, I was active as a shortwave listener. I was, in radio jargon, an SWL and not a ham, meaning I only listened and didn't transmit. It was great fun to tune in distant stations, and the more challenging the better, which is why the Falkland Islands were always high on the list (I never received their station), and Tristan da Cunha was the ultimate catch (all but impossible here on the US east coast).

It wasn't long before I drifted into utility DXing, listening for non-broadcast stations in remote places, everything from low-frequency aviation beacons to ship-to-shore communications, and I got a kick out of monitoring radiotelephone traffic from places like Little America (Antarctica) back to the States. Finally my interests converged and I started thinking about the ultimate DX - receiving a signal from the stars.

SETI efforts were in their early days then, but I began to wonder whether an amateur receiving rig could hope to snag some kind of extraterrestrial utility beacon. I joined SARA, the Society of Amateur Radio Astronomers, but finally realized that my talents lay in writing, not wiring, and that I didn't have the skills to put together the equipment I needed. It's a pleasure, though, to see that SARA is still active and that the SETI bug has now become more broadly established within the organization.

Now affiliated with the SETI League, SARA will be holding its annual technical conference at a storied place, the National Radio Astronomy Observatory in Green Bank, WV. This is where Frank Drake first turned human receivers on specific stars, choosing Epsilon Eridani and Tau Ceti as his targets and more or less inventing the modern discipline of SETI (interesting earlier ideas stretching back considerably farther in time also figure in to SETI's lineage, about which more some other time).

The conference, to be held July 1-3, covers everything from gamma ray burst detection to astrochemistry with a fine array of speakers you can see here along with abstracts of their talks. The SETI League itself is an attempt to privatize SETI work,

reminding us of the contributions of amateurs as well as interested professionals in carrying on the search. And that reminds me of something Freeman Dyson said in a recent interview about the role of amateurs and the scientific hierarchy:

"I like to remind young scientists of examples in the recent past when people without paper qualifications made great contributions. Two of my favorites are: Milton Humason, who drove mules carrying material up the mountain trail to build the Mount Wilson Observatory, and then when the observatory was built got a job as a janitor, and ended up as a staff astronomer second-in-command to Hubble. Bernhard Schmidt, the inventor of the Schmidt telescope which revolutionized optical astronomy, who worked independently as a lens-grinder and beat the big optical companies at their own game. I tell young people that the new technologies of computing, telecommunication, optical detection and microchemistry actually empower the amateur to do things that only professionals could do before."

Dyson himself is an example, a man who simply became too busy to find time to get the standard degree (he had joined the Cornell faculty in 1951 as a physics professor without a PhD), and whose contributions have kept him similarly engaged ever since. In a 2005 commencement address at the University of Michigan, Dyson said he had "...fought all my life against the PhD system and everything it stands for." While he is hardly an amateur, this remarkable scientist reminds us of the range of technologies that open up research to people wherever they stand in terms of formal credentials.

Sometimes I chuckle at the folly of my own preconceptions. I had thought until about ten years ago that I had missed out on the great era of amateur radio, assuming it to have occurred back in the 1920s and 30s, when people built their own equipment in their basements and television had yet to invade the home. But we're in a golden age right now, in radio and much else, and looking at the resources available with a touch of my keyboard sometimes makes my head spin. It's great to see the continuing efforts of the good people at SARA and the SETI League as they push the state of the art with their own work.

This editorial first on the Centauri Dreams website (www.centauri-dreams.org), and is used here by the kind permission of the author. ❖

SETI League Presents Annual Awards

Little Ferry NJ., 29 April 2007 -- At its Annual Meeting this afternoon at its New Jersey headquarters, the nonprofit SETI League, leaders in a global search for extra-terrestrial intelligence, recognized two individuals for major contributions to the art and science of SETI. Honored this year were Dr. Robert Melville of New Jersey (for work performed while a science technician in Antarctica), and David Ocame, a neurosurgery research associate at Yale University (for SETI efforts conducted from his Connecticut home).

The SETI League recognized Bob Melville, an active amateur radio operator (callsign WB3EFT) and SETI League member, with its annual Giordano Bruno Memorial Award, for his significant technical contributions to SETI science. During a yearlong deployment to the Amundsen-Scott South Pole Research Station, Melville braved the elements to construct a fully operational Project Argus radio telescope, and performed the first-ever SETI observations from the Bottom of the World. When he rotated back to the US after thirteen months on the ice, Melville left his South Pole SETI Station intact for use by future researchers.

David Ocame, amateur radio callsign WS1ETI, was selected to receive The SETI League's annual Orville Greene Service Award, for exemplary volunteer service to the nonprofit organization. Ocame chairs The SETI League Awards Committee, operates a Project Argus station from his Connecticut home, is listed on the ETCC (Extra-Terrestrial Century Club) Honor Roll for having documented reception of ten identified extra-terrestrial radio sources, and has contributed numerous articles to The SETI League website, the organization's quarterly newsletter *SearchLites*, and various Conference Proceedings. The Trustees of The SETI League bypassed their Awards Committee's recommendations in making this surprise presentation to Ocame.

In other actions at today's meeting, the Trustees of The SETI League, Inc. accepted the Executive Director's and Secretary/Treasurer's annual reports, adopted a 2007 budget, re-elected its officers (Richard Factor, WA2IKL, President; A. Heather Wood, Secretary/Treasurer; H. Paul Shuch, N6TX, Chief Operating Officer) to serve on a volunteer basis for an additional one-year term, and agreed to resume cost sharing of the Executive Director Emeritus' health insurance premiums.

Largely using radio telescopes and optical telescopes, SETI scientists seek to determine whether humankind is alone in the universe. Since Congress terminated NASA's SETI funding in 1993, The SETI League and other scientific groups have privatized the research. Amateur and professional scientists interested in participating in the search for intelligent alien life, and citizens wishing to help support it, should email join@setileague.org, check the SETI League Web site at <http://www.setileague.org/>, send a fax to +1 (201) 641-1771, or contact The SETI League, Inc. membership hotline at +1 (800) TAU-SETI. Be sure to provide us with a postal address to which we will mail further information. The SETI League, Inc. is a membership-supported, non-profit [501(c)(3)], educational and scientific corporation dedicated to the scientific Search for Extra-Terrestrial Intelligence. ❖

Technical Program Takes Shape

Little Ferry, NJ., April 2007 -- Members of the Society of Amateur Radio Astronomers (SARA), a SETI League Affiliated Society that represents several hundred amateur radio astronomers around the world, have announced a preliminary schedule for their annual technical conference, to be held 1 - 3 July 2007 at the National Radio Astronomy Observatory, Green Bank, WV.

Speakers and topics lined up for this joint SARA / SETI League event include:

- Andrew Clegg - Present and Future Radio Spectrum Trends (keynote presentation)
- David Fields - Conservation of Dark Skies and Radio Spectrum Space
- William Marshall - Carbides if Present in Stellar Dust and Origin-of-Life Precursors
- Jon Wallace - How to Present Radio Astronomy to a General Audience Group
- Tyler Moore - Construction of an Integrated Observation Network
- Bruce Lerner - Astro-chemistry - A Review of the Contributions of Radio Astronomy
- Panel Discussion - the NRAO Navigator Program
- Jon Wallace - Solar and VLF Observing
- Heather Fries - A Celestial Plot of HI and other Radio Sources
- Paul Oxley - Designing a Tunable LO for ELF Measurements
- David Ocame and Marcus Leach - A year of Gnu Radio and SDR Astronomy
- John Mannone - Gamma Ray Bursts and Amateur Radio Astronomy
- H. Paul Shuch - Shouting in the Jungle: the SETI Transmission Debate
- Jasim Mutlaq - Scheduling, Automation, and Control in Astronomical Instrumentation

In addition to these formal technical talks, the SARA Conference will include poster sessions, social events, coffee breaks with refreshments, radiotelescope tours, the traditional group photo session, business meetings, and the annual SARA Membership Meeting, which will include election of officers. A formal printed Proceedings for this meeting will be provided to all registered attendees. SETI League members unable to attend the 2007 SARA Conference may purchase the published Proceedings of this meeting through The SETI League website.

The preliminary schedule for the three-day conference is posted to the SARA website, at:

<http://radio-astronomy.org/meetings/sched07.htm>

Abstracts of technical talks may be found online at:

<http://radio-astronomy.org/meetings/abstr07.htm>

Advance registration for the conference is required; details appear at:

<http://radio-astronomy.org/meetings/grbank07.htm> ❖

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Minutes of the Thirteenth Annual Membership Meeting 29 April 2007, SETI League Headquarters, Little Ferry, NJ

- **Call to Order**

The meeting was convened at 1306 hours EDT, in the Library at SETI League Headquarters, Little Ferry NJ, by Executive Director Emeritus Dr. H. Paul Shuch. Eight SETI League members in good standing present. Our Bylaws requiring one percent of the current membership to be in attendance for the conduct of SETI League business, the above represents a quorum.

- **Minutes of 2006 Membership Meeting**

The Minutes of the 2006 Membership Meeting having been previously posted to The SETI League's World Wide Web site, a motion was passed to accept the minutes as published.

- **Treasurer's Report**

Presented jointly by the Executive Director and the Secretary/Treasurer, covering the calendar year 2006 (as filed).

1. Revenues: Dues and Contributions \$12,343, Interest Income \$225, Total \$12,568.
2. Expenses: Educational/Scientific Programs \$8,678, Management/General \$5,477, Fundraising \$2,521, Total \$16,677.
3. Revenues minus Expenses: (\$4,109) [deficit].
4. End of 2006, SETI League account balances equalled \$4,603. End of 2005 balance was \$8,712.
5. Current balance (cash on hand and owed) is approximately \$6,500.
6. 2006 Budget: Projected Revenues \$12,000, Program Expenses \$9,000, Management/General Expenses \$2,500, Fundraising Expenses \$2,500, Projected Deficit \$2,000, Projected Ending Balance \$2,603.
7. This report was accepted by those present.

- **Executive Director's Report**

The Executive Director's annual report of Program Service Accomplishments having been previously posted to The SETI League's World Wide Web site, a motion was passed to accept the report as published.

- **Committee Reports**

1. **EME Committee**

Report delivered by Richard Factor in the absence of chairman Dr. Allen Katz: Our moonbounce beacon is now off the air. After more than a year of reliable operation with the new power amplifier installed, transmitter power began to drop off in March. As new antennas have been purchased but not yet installed, it was decided to take the system offline until antenna installation is completed, and then to troubleshoot the power train. It remains our goal to make the beacon signal receivable by the "typical" Project Argus sta-

tion. To date, the smallest system to have reported successful reception was using a 13 foot parabolic reflector.

2. **Awards Committee**

Report delivered by chairman David Ocame: Twelve websites were selected in 2006 to receive the SETI SuperStar Award. Three nominees for the Giordano Bruno Memorial Award were recommended to the Board for consideration.

- **Old Business**

1. **Mid-Year Renewal Letter**

Secretary/Treasurer Heather Wood reports that a mid-year letter to lapsed members brought in roughly \$400 in dues revenue, at an approximate cost of \$100 for printing and postage. It was recommended that The SETI League continue issuing such mid-year appeals.

2. **EME Antennas**

It was reported that the new moonbounce antennas purchased last year have been in the hands of a professional installer for many months, but that installation is yet to be scheduled. Richard Factor will attempt to secure a commitment and time schedule from our installer.

3. **Annual Report**

Hardcopies of The SETI League's 2006 Annual Report have been distributed to all members of the Board. The entire document is available to members via the website, in Portable Document Format (PDF).

- **New Business**

1. **Steward Observatory Proposal**

Member Peter Vikius has met with Steward Observatory personnel in Arizona, toward the goal of offering The SETI League an opportunity to manage allocation of time on the 12 metre diameter millimeter-wave radio telescope on Kitt Peak, as a potential source of SETI League revenue. It was noted that, with no paid staff and only limited volunteer support, The SETI League lacks the resources to accept this opportunity at this time.

2. **SARA Proceedings**

Last year, in lieu of sponsoring a SETICon technical meeting, The SETI League assisted the Society of Amateur Radio Astronomers (SARA), a SETI League affiliated society, in conducting its annual technical conference at NRAO Green Bank WV. The Executive Director Emeritus served as Editor of the Proceedings of that conference. Based upon the success of that venture, The SETI League will be assisting with this year's SARA Conference, and editing SARA's 2007 Proceedings as well.

3. Extensive discussions ensued regarding a special program to honor those Charter Members who have remained members in good standing. It was decided to offer copies of various SETI League publications to libraries and schools, and to offer membership gratis to full-time students, on a trial basis.
4. The next Annual Meeting will be held at the same venue. The dates of Sunday 20 April 2008 and Sunday 27 April have been suggested. A date will be selected so as to avoid a scheduling conflict with the Trenton Computer Festival, and the date announced via the website and newsletter. The meeting will be at 1300 hours EDT, to be followed immediately by the Board of Trustees meeting.
5. Awards Committee chairman David Ocame presented the Giordano Bruno Memorial Award to member Robert Melville, in recognition of his having activated the first SETI station at the South Pole. In a move that surprised our Awards Committee chairman, the Executive Director Emeritus then presented the Orville N. Greene Service Award to Mr. Ocame, in thanks for his exemplary volunteer service to The SETI League.

- **Good and Welfare**

- o Robert Melville gave a PowerPoint presentation of his SETI activities at the South Pole.

- **Adjournment**

The Annual Membership Meeting was adjourned by the Executive Director at 14:25 hours EDT on 23 April 2006. The annual Board of Trustees meeting occurred immediately afterward. All members in good standing were invited to attend.

Business Transacted by Board of Trustees:

1. **Quorum Call**

Trustees and Officers present: Richard Factor, Heather Wood, Marc Arnold, Martin Schreiber, H. Paul Shuch. Trustees and Officers absent: none. A quorum is present.

2. **Election of Officers**

The following slate of officers was retained for a one-year term:

President - Richard Factor
 Secretary/Treasurer - A. Heather Wood
 Executive Director Emeritus - H. Paul Shuch, serving on a volunteer basis.

3. **Personnel matters**

Board of Trustees voted to resume its previous cost-sharing of Executive Director Emeritus' health insurance premiums, as an administrative expense, pending availability of funds and subject to periodic review. Dr. Shuch abstaining.

Respectfully submitted, A. Heather Wood, Secretary ❖



At the 2007 SETI League annual meeting, executive director emeritus H. Paul Shuch (center) presented the Orville N. Greene Service Award to David Ocame (left), and the Giordano Bruno Memorial Award to Bob Melville (right).



The Trustees and Officers at the 2007 Board Meeting. (left to right:) Executive Director Emeritus H. Paul Shuch, Trustee Marty Schreiber, Trustee Marc Arnold, President Richard Factor, and Secretary/Treasurer A. Heather Wood.

Ask Dr. SETI:

Planck, Wien, and Magic Frequencies

Dear Dr. SETI:

In a recent column, you derived the peak of the cosmic microwave background radiation, and come up with a frequency of 279.5 GHz. Other references show the peak frequency at 160.4 GHz. That is a pretty significant discrepancy. Which is right? Certainly, they can't both be correct, can they?

Mike, Virginia

The Doctor Responds:

Yes, Mike, in fact, they can be, and are, both correct. The apparent discrepancy derives from the difference between discrete and continuous random variables, giving rise to two different definitions of "peak frequency."

The familiar Planck Curve, which shows how energy emitted by a thermal blackbody varies with frequency, appears to

be a smooth curve. In fact, because energy is quantized, it is really a collection of discrete points, which only *appear* continuous. The independent variable depicted in a Planck Curve is not actually energy *per se*, but rather energy *per unit of frequency*, or alternatively, energy *per unit of wavelength*.

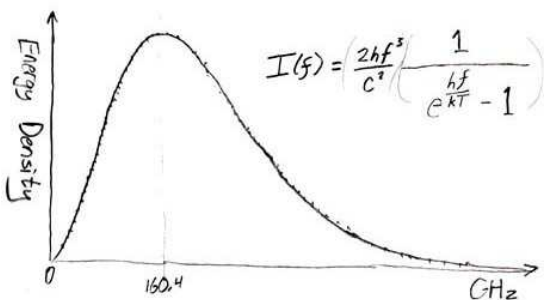
Since frequency and wavelength are related to each other by the speed of light, you might expect the two definitions to yield identical curves, with identical peaks. This is, however, not the case when we are talking about energy per *bin*. Because frequency and wavelength are inversely proportional, across the electromagnetic spectrum the respective widths of frequency *bins* and wavelength *bins* will also vary inversely one with the other.

When I previously evaluated the peak of the 2.7 Kelvin cosmic background radiation, I invoked Wien's Law. The resulting quotient of Wien's Constant over temperature produced an accurate calculation of 1.0733 mm as the wavelength at which the thermal energy *per unit wavelength* is at a maximum. This figure corresponds to a peak frequency of 279.5 GHz. (In fact, recent measurements from the Wilkinson Microwave Anisotropy Probe show a more precise figure of 2.715 Kelvins as the cosmic background temperature, which yields an ever so slightly different frequency of 281 GHz. For the purposes of this investigation, we can consider these two frequencies to be equal.)

However, using methodology just as sound, we can come up with an entirely different result, a frequency not at all equal to the above. Consider this alternative solution, based upon Planck's Law. One formulation of it, reproduced here, shows the distribution, as a function of temperature, of thermal energy *per unit frequency*:

$$R_T(f)df = \frac{8\pi Vhf^3 df / c^3}{e^{hf/kT} - 1}$$

Plotting the above equation over frequency yields the familiar Planck Curve which we all know and love. Here's what it looks like:



To determine where the curve peaks, we set the derivative of the equation equal to zero, and solve for frequency. This gives us, of course, the frequency at which the slope of the curve equals zero (that is, the curve's amplitude peak). Inserting Planck's Constant, Boltzmann's Constant, and a temperature of 2.715 Kelvins, we find that this peak occurs at frequency of 160.4 GHz, the solution you cite in your question. And this solution, like my initial one, is also entirely correct. There's an Excel Spreadsheet on The SETI League website that will let you experiment with blackbody curves of other temperatures.

The two results differ because, in the first case, the peak being calculated is the maximum for a curve of thermal energy per unit of *wavelength*. In the latter computation, it is maximum thermal energy per unit of *frequency* we have computed.

Which is correct? They both are. Which, in the context of SETI, represents a universally recognizable "magic frequency"? They both do.

So, which frequency should we search for alien electromagnetic artifacts? I think the answer is obvious: both.

Dear Dr. SETI:

I've run into a problem where math and intuition seem to be giving different answers. When that has happened in the past, either I was looking at the problem wrong, or I had done the math wrong.

Here is the intuition part: if I live right on the equator and point my antenna to the Eastern horizon (90 degrees azimuth at zero degrees of elevation), that point should give me maximum positive Doppler, right? Then, if I keep the antenna locked onto that position, the point being monitored will rise in the sky until it is at its zenith. My antenna should now be pointed up at 90 degrees elevation, and Doppler should be at a minimum. Then, as the point starts to set in the West, and I track it with my antenna, the Doppler shift should go negative, and reach its maximum negative just as the radiant sets - right?

So, the Doppler should go through a one-half wave of a sine from Max positive to Max negative, and the slope of the Doppler curve should always be negative.

Here is the math part: using the Excel spreadsheet on the website for Geo-Rotational Doppler, it never seems to go negative. I can set the hour angle at -6 hrs (point at the Eastern horizon) or +6 hrs (point at the Western horizon) and the Doppler sign does not change.

What have I missed?

Jim, California

The Doctor Responds:

I don't think you've missed anything, Jim, although your spreadsheet may have. Your intuitive assessment is roughly correct (though at latitudes other than on the equator, the curve is not exactly sinusoidal). What you have described is the classic Doppler 'S' curve for orbital motion: maximum positive frequency excursion at acquisition of signal (AOS), zero Doppler directly overhead, and maximum negative frequency change at loss of signal (LOS).

I believe what the spreadsheet may be calculating is not absolute received frequency change (Doppler shift), but rather the first time derivative of Doppler shift (the rate of change of frequency over time). In other words, you are seeing the *slope* of the Doppler curve, which is nearly zero at AOS, maximum at closest approach (zenith), and nearly zero at LOS.

By the way, as you suspected, the sign of this slope is always negative (frequency continuously decreasing), and can never go positive. I suspect the spreadsheet is merely displaying the *magnitude* of the rate of change of Doppler shift, since the sign is constant (therefore irrelevant). That is to say, if the Doppler rate (first time derivative of frequency) is "100 Hz per minute", it goes without saying that this is a change in frequency which is *negative* over time. ❖



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Annual Renewal: Is This Your Last SearchLites?

SETI League memberships are issued for the *Calendar Year*. Please check the expiration date indicated on your mailing label. If it reads December 2006 or earlier, you have already expired, and *must* renew your SETI League membership **now!** Please fill out and return this page along with your payment.

Please renew my membership in this category:

Full Member	\$50 / yr
Supporting Member (elderly, retired, or disabled)	\$35 / yr
Scholarship Member (full-time students only)	\$25 / yr
Household Member (same address as a Full Member)	\$15 / yr
Household Life Member (same address as a Life Member)	\$300
Life Member (until we make contact)	\$1,000
Sustaining Life Member – a generous <i>annual</i> pledge of:	\$1,000 / yr
Patron (priority use of The SETI League's radio telescope)	\$10,000
Director (Patron membership plus seat on advisory board)	\$100,000
Benefactor (a major radio telescope named for you)	\$1,000,000

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.

Pleased to Accept Credit Cards

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.

Circle One: Visa / MasterCard Exp. ____ / ____
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Pocket protectors	\$ 3	\$ 4
Mouse pads	\$ 5	\$ 7
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