



# SearchLites

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The Quarterly Newsletter of The SETI League, Inc.

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## ITAR Attacks!

by H. Paul Shuch, Executive Director Emeritus, The SETI League, Inc.

As SETI scientists, we inhabit a very different world from that in which our neighbors reside. We tend to view our planet from space, as a fragile blue dot floating in a black void. Our world is unified, devoid of political barriers, a spacecraft we all share, one which, together, we must all preserve. Our neighbors live their lives on flat maps, demarked by national boundaries, with individual political subdivisions set apart from one another by distinctive colors. And herein lies the disconnect.

It is our nature to communicate, to share information, to help one another in the pursuit of our research, and the pursuit of our lives. Our community is broad, diverse, and rewarding. We share our planet with friends; unfortunately, the rest of the world perceives a planet full of enemies. No matter how hard we try to convert our neighbors over to our viewpoint, we still have to live within the realities of their world. One of those realities is that governments create barriers to international cooperation, barriers which often restrict our research community's efforts.

The law of the land in the US includes a lengthy provision known as ITAR, for International Traffic in Arms Regulations. Formally consisting of 22 CFR Chapter I Subchapter M Parts 120-130 as amended through 72 FR 31452, ITAR is a litany of legalese now totaling 244 pages. Its stated purpose is to prevent the proliferation of weapons systems. Its sub-purpose is to keep attorneys gainfully employed. Its direct consequence is to stifle international cooperation in many arenas, including the design, construction, and use of radio telescopes.

The intent of ITAR was to preclude the export from the US of weapons systems. As a pacifist, I can hardly argue with this lofty goal. Unfortunately, it has been extended to restrict the distribution beyond US borders of anything that can conceivably be used as part of a weapons system. This broad definition clearly applies to electronics hardware, software, and designs (that is, just about everything that goes into our SETI stations). Further complicating our job as scientists and educators is the fact that ITAR restrictions apply to information, not just material goods. So, I cannot train The SETI League's international membership base in ITAR-restricted technologies, or allow our members to work in the University lab where some of our instruments might be under construction or testing! In other words, ITAR would have us all check citizenship papers before allowing the world's radio astronomers to collaborate in our SETI endeavors. Clearly, these are policies in direct conflict with a scientist's worldview.

One work-around is to employ only technologies which are already generally available worldwide (and to carefully document this fact). Such an approach would preclude design innovation, restricting us from using the latest and greatest in components, circuits, software, or architecture. A powerful example (pun fully intended) is solar electric generation. Under ITAR, we might be precluded from employing on space-based instruments the latest in triple-junction solar cells, the ones that achieve efficiencies on the order of 28%. Instead, we may be forced to use commonly available commercial-grade cells, the kind that struggle to make 10% on a sunny day. All in the interest of world peace, I suppose.

If you're a SETIzen of the world, and want to buy ITAR-restricted components from the US, there are hoops through which you can jump, and forms you can file with the Department of Commerce. This assumes you are a government agency, or giant aerospace corporation, and have your team of lawyers and administrators on staff to wade through months of red tape and reams of paperwork. Most of us in the SETI community would be daunted by the requirements, and just give up.

An interesting irony is that ITAR restrictions may fly in the face of international law. The United States is, after all, signatory to the UN Space Treaty which, among other things, bans all weapons systems in space. That same US government routinely sanctions launch of various communications and remote sensing satellites. Now, if under ITAR our facilities, which are often used to receive signals from those birds, are to be considered weapons systems, does this not imply an admitted violation of the Space Treaty? Seems to me, the bureaucrats can't have it both ways.

Yes, our radio telescopes are weapons. We use them to fight ignorance. Unfortunately, sometimes ignorance fights back. ❖

## 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](http://www.setileague.org)) under *Event Horizon*, or email to us at [info@setileague.org](mailto:info@setileague.org), to obtain further details. Members are also encouraged to send in information about upcoming events of which we may be unaware.

**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.

**October 27 - 28, 2007 (UTC):** *ARRL International EME Competition*. Listen for The SETI League's 1296 MHz Moonbounce Beacon.

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

**November 24 - 25, 2007 (UTC):** *ARRL International EME Competition*. Listen for The SETI League's 1296 MHz Moonbounce Beacon.

**April 4 - 8, 2008:** I-Con 27, Stony Brook University, NY.

**April 15 - 17, 2008:** *Astrobiology Science Conference*, Santa Clara CA.

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

**April 20, 2008, 1:00 PM Eastern Daylight Time:** Fourteenth SETI League *Annual Membership Meeting*, Little Ferry NJ.

**April 20, 2008, 2:00 PM Eastern Daylight Time:** SETI League *Annual Board of Trustees Meeting*, Little Ferry NJ.

**April 25 - 26, 2008:** *Southeastern VHF Conference*, Orlando FL.

**April 25 - 26, 2008:** *Trenton Computer Festival*, The College of New Jersey, Trenton NJ.

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

**May 23 - 26, 2008:** *Balticon 42*, Baltimore MD.

**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 - 26, 2008:** *Central States VHF Conference*, Wichita KS.

**August 8 - 10, 2008:** *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.

**July 23 - 25, 2009:** *Central States VHF Conference*, St. Charles IL.

**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. ❖

## Remembering:

### Prof. Ronald N. Bracewell

by H. Paul Shuch, Executive Director Emeritus

The SETI community has lost another of its pioneers, with the passing on 13 August 2007 of noted radio astronomer Ronald N. Bracewell. At the time of his death, Prof. Bracewell was the Lewis M. Terman Professor of Electrical Engineering (Emeritus) at Stanford University, where he had taught since 1955.

Born in Sydney, Australia in 1921, Ron Bracewell served during the Second World War as a microwave and radar engineer at the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization (CSIRO), Sydney, before completing his Ph.D. in Physics at Cavendish Laboratory, Cambridge. He returned to CSIRO as a Senior Research Officer at the Radiophysics Laboratory, prior to coming to the US in 1954, first lecturing in the Astronomy Department at the University of California, Berkeley, and the following year moving across the bay to Stanford.

In 1955, Bracewell co-authored with J.L. Pawsey, his former supervisor at CSIRO, *Radio Astronomy*, probably the first textbook in this emerging discipline. Other significant publications include the standard EE textbook *The Fourier Transform and its Applications* (1965), the popular SETI book *The Galactic Club: Intelligent Life in Outer Space* (1974), several works on image processing, and two books on trees found in the vicinity of the Stanford campus. Ron strongly believed in the possibility that advanced extraterrestrial civilizations would explore the cosmos by constructing autonomous robotic probes, and today these hypothesized exploration vehicles are universally known as Bracewell Probes.

At Stanford in 1961, Ron Bracewell and his grad student Govind Swarup (later to become director of the India Centre for Radio Astrophysics) constructed an innovative 4 GHz spectroheliograph on the Stanford campus, a pencil-beam interferometer with micro-steradian resolution. Consisting of 32 3-meter dishes in a Mills Cross arrangement, that design inspired The SETI League's own Very Small Array (VSA) project, to which Ron contributed design expertise. My first direct contact with Ron Bracewell occurred upon the dismantling of the Stanford spectroheliograph in the late 1970s, with Ron contributing one of the dishes to San Jose City College. I was teaching there at the time, and this Stanford dish became my students' first radio telescope (as well as a forerunner of today's Project Argus instruments).

Ron Bracewell had a strong interest in Optical SETI, and presented papers at each of the OSETI conferences sponsored by SPIE, the international photo-optical society. He introduced significant modifications to the Fast Fourier Transform which facilitate improved image processing, and developed algorithms still widely used by SETI League members for candidate signal analysis. I shall remember Professor Bracewell every time I fire up my Digital Signal Processing computers.

❖

**Editor's Note: If this issue of SearchLites seems a little thin to you, it's because you haven't contributed to it! Submit your contributions by email to [paul@setileague.org](mailto:paul@setileague.org) today.**

Guest Editorial

## How Accurate Must We Be?

by Richard Factor

The ARRL, to which many SETI League members belong, is and has been since the beginning of ham (amateur) radio the umbrella organization for its practitioners in the US. ARRL initially stood for American Radio Relay League; through some marketing sorcery, it now apparently stands for National Association for Amateur Radio. A very large percentage of us join, although we are under no obligation to do so, and its magazine, the engagingly titled "QST" is an important historical and technical journal in our radio lives. The ARRL sponsors various activities and promulgates the rules and dates in QST. For example, "Field Day" is an annual event at which time hams will leave their comfortable homes to erect antennas in public parks, farm fields, and mountain tops and attempt to contact others so-situated over the radio. One major contributor to the non-profit ARRL is the mosquito repellent manufacturers association.

The majority of ARRL-sponsored activities could be considered "social" in the sense that, as does Field Day, they involve a bunch of hams getting together to do something. Others are social in the sense that the goal is for hams to contact each other on the radio and exchange information. But one activity is both solitary and nerdy: The "Frequency Measuring Test." In the FMT, the ARRL uses its headquarters radio station W1AW to transmit signals at several different frequencies in the amateur radio bands, and it is up to the entrants to measure the frequencies as precisely as they are able to. For example, the contest announcement may say that W1AW will be transmitting on (approximately) 1853, 3586, and 7039 kHz. The mission would be to refine that to 1853,059.2 Hz, etc.

In order to do this, you have to have a number of capabilities:

- You have to find the signal with your receiver. Although this is usually easy, you must contend with "band conditions" and weak signals, not to mention possible interference from other users who share the frequency.
- You have to identify the signal. They identify in Morse Code, so if you don't speak Morse you might pick the wrong signal.
- You have to measure the frequency of the signal as precisely as possible. Depending on your equipment, which you have hopefully recently calibrated, you might be limited to measuring to the nearest 100 or 10 Hz. It actually takes a bit of precision work to get to the nearest Hz and fraction thereof. (A "Hz" is just a "cycle per second" in new clothes. An AM broadcast station, e.g., 1010 WINS, transmits on 1,010,000 Hz.)

Needless to say, the FMT is one of my favorite ham (and nerd) activities. I can sit, (alone, of course,) amongst the glowing lights and screens of my test equipment and reduce hours of effort and kilobucks of hardware to three or four precise numbers, each of which agrees closely with its counterpart number measured at ARRL Headquarters over a hundred miles from here. What's not to enjoy? But the best part of the FMT for me was that I was able to prove the ARRL wrong in one of their assumptions about the contest. As every SETI League member knows, there is no greater nerd satisfaction than doing some-

thing that you are told can't be done. My joy was ameliorated to some extent in that I think the "can't be done" assertion wasn't well thought out. In early announcements of the FMT in QST, ARRL asserted that accuracies greater than 1 PPM weren't possible. Hah! (1 PPM is 1 Hertz per megahertz. For example, it's "impossible" to measure the 7039 frequency to better than 7Hz. Did I mention "Hah!?"?) This surprised me when I saw it, and in later years they dropped the claim. I'd like to feel that I contributed to their change of theory.

So, how well do I do in the FMT? Between 2003 and 2006, my very worst result was .26 PPM, and most were .1PPM or (much) better. Is this close enough for SETI work? Probably. Our Project Argus stations typically monitor the spectrum surrounding 1420 MHz, the precession frequency of interstellar neutral hydrogen atoms. An error of .1 ppm at the hydrogen line translates to 142 Hz of frequency uncertainty. If our digital signal processing bins are (typically) 10 Hz wide, this means we can be off by fourteen bins in assessing any received signals, and never know it. Of course, since our software monitors many thousands of bins at a time, this might not particularly matter, at least in the signal acquisition phase of our search.

**Disclaimer:** *The opinions expressed in editorials are those of the individual authors, and do not necessarily reflect the position of The SETI League, Inc., its Trustees, officers, Advisory Board, members, donors, or commercial sponsors.* ❖

## 2007 SARA Proceedings Now Available

For the second year in a row, the nonprofit, membership-supported SETI League is proud to announce the availability of a published Proceedings for the annual Conference of The Society of Amateur Radio Astronomers. SARA is a SETI League Affiliate Society that represents several hundred amateur radio astronomers around the world. This Proceedings is published in conjunction with SARA's 2007 Annual Meeting, being held July 1 - 3, 2007, at the National Radio Astronomy Observatory (NRAO), Green Bank WV. The Proceedings includes papers on radio astronomy hardware, software, education, research strategies, and philosophy, several submitted by SETI League members.

All papers in this formal Proceedings were peer-reviewed by a panel of SARA members with appropriate professional expertise and academic credentials. Prof. H. Paul Shuch, The SETI League's Executive Director Emeritus, also serves as SARA vice president on a volunteer basis. In that capacity, he served as editor of the 2007 SARA Conference Proceedings, as well as coordinator for the joint technical meeting. Further information about SARA and their annual conference can be found on the SARA website, radio-astronomy.org.

The Table of Contents for the 2007 SARA Proceedings appears elsewhere in this issue. One copy of the Proceedings was provided to each registered attendee at the 2007 SARA Conference. To benefit those SARA and SETI League members unable to attend, copies are now available from The SETI Store for a suggested contribution of \$20 US postpaid to US addresses, or \$25 US elsewhere. The SETI League still has copies of last year's SARA Proceedings available as well, for the same suggested contribution. ❖

*Publications Department:*

**Proceedings of the 2007 Conference of the Society of Amateur Radio Astronomers**

**Now available --** *Proceedings of the 2007 Conference of the Society of Amateur Radio Astronomers.* Many SETI League members contributed to this July 2007 Conference, hosted by our sister society, SARA. Published by the American Radio Relay League. ISBN 0-87259-997-3.

**Suggested Contribution:** \$20 postpaid in US, \$25 postpaid elsewhere.

*SETI League photo*



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**Right: Author Rob Sawyer visits The SETI League's Very Small Array (VSA) radio telescopes >>**

**Featured Song:**

**Rollback**

*Inspired by the novel of the same title by Rob Sawyer*

**lyrics © 2007 by Dr. H. Paul Shuch**  
**sung to the tune of "Rolling Down on Old Maui" (traditional)**

It's a damned fine life, little toil or strife these four score and seven years.  
But it's winding down. Not a tear or frown; of the end Sarah has no fears.  
Then a call's received, as she long believed. Though her days are drawing short,  
What is heard this day only she can say, so to work Sarah must report.

CHORUS:

Roll her back to twenty five, I say, roll her back to twenty five.  
For her no sleep, we have to keep Ms. Halifax alive.

Ms. Halifax was a clever lass. She decoded the Call from the Sky  
Back in two k nine. Her brilliant mind helped us craft Planet Earth's reply.  
When the Sigma Dracons saw her note, they'd respond, she knew without fail.  
But the round-trip time is thirty eight years, and by then she'd be old and frail.

CHORUS

The answer came on schedule, just like Sarah always knew:  
A response to her message from long ago - and a scrambling sequence too.  
An encrypted message from aliens? Sarah thought, "how can this be?"  
Though the algorithm was evident, only Sarah could find the key.

CHORUS

The cost of Rollback technology is a small nation's GDP.  
A fountain of youth for billionaires, Sarah thought, but not for me.  
A tycoon, self made, promised all bills paid, if she would carry on.  
Smiling at their past, she agreed at last: "But not without my love, Don."

ALTERNATE CHORUS:

Roll them back to twenty five, I say, roll them back to twenty five.  
For them no sleep, we have to keep both Sarah and Don alive.

Rollback reliability leaves a lot to be desired.  
The result achieved with Don and Sarah is not what was required.  
With one made young and the other old (I won't tell which is which),  
We see a clever plot unfold, and it shows that life's a bitch.

CHORUS

I will not spoil the ending of this entertaining tale,  
For you can buy a copy wherever fine books are on sale.  
The novel's "Rollback" by Robert Sawyer, the publisher is TOR,  
So you will have to read it if you are wanting to learn more.

CHORUS



## SETI League Director Emeritus Honored by Astronautics Academy

Little Ferry, NJ., August 2007 -- H. Paul Shuch, the author, educator and engineer who heads up a grass-roots Search for Extra-Terrestrial Intelligence, has been elected to Full Membership in the prestigious International Academy of Astronautics (IAA). A Corresponding Member of the academy since 2003, Prof. Shuch left a successful academic career in 1995 to become Executive Director of the newly founded SETI League, an international nonprofit organization. Currently, as Executive Director Emeritus, he remains responsible for planning and implementing The SETI League's educational, scientific, technology and outreach programs. His elevation to Full Membership in the academy will be formalized at this year's International Astronautical Congress, to be held next month in Hyderabad, India.

The IAA is a scientific institution devoted to fostering the development of astronautics for peaceful purposes, recognizing individuals who have distinguished themselves in a branch of science or technology related to astronautics, and providing programs through which the membership can contribute to international endeavors in the advancement of aerospace science. It was founded in Stockholm in 1960 by the noted aerodynamicist Dr. Theodore Von Karman.

With his elevation to Full Member, Dr. Shuch joins several hundred distinguished space scientists and engineers from 60 countries, including two other SETI League members, in lifetime IAA membership. The academy cooperates, exchanges and conducts joint meetings with national academies, and prepares cosmic planning studies through its six commissions. The academy also organizes many independent international scientific meetings, such as the Humans in Space, Small Satellite, Low Cost Planetary Mission, Realistic Near-term Advanced Scientific Space Mission, and Impact of Space Technology Innovation on Economic Development conferences.

Dr. Shuch was appointed to the IAA's SETI Permanent Study Group in 2000, and currently serves as its co-chairman and webmaster. He has presented papers at nine different IAA meetings in Europe, North America, South America, and Asia, and published articles in its peer reviewed scholarly journal, *Acta Astronautica*. "This bodes well for SETI," says Shuch of his election to Full Membership, "because it is yet another indicator that our research is being accepted, and respected, by the mainstream scientific community."

SETI scientists seek to determine through microwave and optical measurements whether humankind is alone in the universe. Since Congress terminated NASA's SETI funding in 1993, The SETI League and other scientific groups have been attempting to privatize the research. Experimenters interested in participating in the search for intelligent alien life, or citizens wishing to help support it, should email to [join\\_at\\_setileague\\_dot\\_org](mailto:join_at_setileague_dot_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 electromagnetic Search for Extra-Terrestrial Intelligence.



Ask Dr. SETI

### Relativistic Mass

Dear Dr. SETI:

*Do photons have mass?*

Adam (student)

**The Doctor Responds:**

Of course they do, Adam. But only if they're Catholic.

Okay, a serious question (succinct and to the point) requires an equally serious answer. Your question raises some non-trivial issues.

Einstein defined the photon as a massless particle of pure electromagnetic energy. Unfortunately, Einstein also described a mass-energy equivalency. So, if photons are energetic, they must have mass. How we do resolve Einstein's contradiction? By postulating the concept of relativistic mass.

Try this experiment: grab hold of a photon (this may be more difficult than it sounds, because photons are both remarkably quick and uncommonly slippery), place it on a triple beam balance, and measure its mass. As long as it remains stationary on the scale, the photon is indeed massless (just as Einstein advertised). So far, so good.

Except that photons don't do a very good job remaining motionless. In fact, they tend to propagate at a fixed velocity (which we call the speed of light). In free space, that velocity is 300 million meters per second. (In media other than vacuum, photons move more slowly; your mileage may vary.) The speed of light is, of course, a relativistic velocity -- which is how photons in motion acquire relativistic mass.

Planck's Law tells us that the energy of a photon is frequency dependent, and can be quantified as

$$e_p = h * \nu$$

where  $e_p$  represents the energy (in Joules) of a single photon,  $\nu$  is the photon's frequency, in cycles per second, or Hz, and  $h$ , Planck's Constant, is a fudge factor to make all the units come out with dimensional consistency. (The accepted value for Planck's Constant is  $6.626*10^{-34}$  J\*s; glad you asked.)

Relativity theory tells us that the energy of a particle is related to its mass and the speed of light by the familiar relationship:

$$e = m*c^2$$

This suggests that if we know the mass of a photon, since we know the value of its velocity ( $c$ ), we can compute its energy. Conversely, if we know the energy of a photon, we should be able to rearrange relativity, and solve for its equivalent mass.

The next step is to assume the Planck energy of a photon and its relativistic energy are equal. This would leave us with:

$$h * \nu = m * c^2$$

[Planck = Einstein]

and a little algebraic manipulation yields an expression for the (frequency-dependent) relativistic mass of a photon:

$$m = h * \nu / c^2$$

Let's try this relationship on for size with a familiar photon emitted by the spin-flip of neutral hydrogen. The resulting frequency, 1420 MHz, is a popular spot on the SETI dial. Plugging in this frequency, Planck's constant, and the speed of light, we see that an H1 photon has a relativistic mass on the order of  $1*10^{-41}$  kg. Not terribly heavy, to be sure, but still, clearly, a non-zero mass.

And hydrogen line photons aren't even Catholic.





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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:**

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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.

**Order Your Membership Premiums:**

**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.

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<i>Project Cyclops 2<sup>nd</sup> Edition</i>	\$20	\$25
<i>The Listeners</i> by James Gunn	\$15	\$15
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SETI Nerd Gift Set (one each Mouse Pad, Pocket Protector, <i>Project Cyclops</i> and <i>Tech Manual</i> ) at 20% Savings to <u>Members Only</u> :	\$30	\$40

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