American Astronomical Society Small Research Grant Proposal

Title: A Lunar Reflective Calibration Beacon for Global Coordinated Radio Astronomy
Applicant: H. Paul Shuch, Ph.D. (email paul@setileague.org)
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Statement of Purpose: To provide a readily accessible, continuously available source of extra-terrestrial microwave test and calibration signals, for use by radio telescopes around the world.

Summary of Research: The SETI League, Inc. is an international organization involved in radio astronomy and the electromagnetic Search for Extra-Terrestrial Intelligence (SETI). *Project Argus*, the League's primary research effort, coordinates hundreds of small radio telescopes operated by League members on six continents. This grant will fund completion of construction (already begun) of an L-band (1296 MHz) beacon transmitter and automated tracking antenna system, which will provide constant real-time microwave calibration and test signals via reflection off the lunar surface. Said beacon will be available to the radio astronomy community (including SETI League amateur radio astronomers and professional facilities worldwide) whenever the moon is above the observer's and the transmitter's mutual horizon. The proposed facility will help member stations to operate in accordance with sound engineering practice, and provide for credible, coordinated scientific observations.

Importance and Relevance:

NASA HRMS (High Resolution Microwave Survey), a modestly funded SETI observation program launched in 1992, was terminated by Congress in 1993. The SETI League and other non-profit organizations have endeavored to privatize that research. The proposed lunar beacon will furnish amateur and professional radio astronomers alike with a freely available source of calibration signals, on a par with those available to NASA during their short-lived SETI observations. In a climate of increasing privatization of scientific projects, we hope to demonstrate that radio astronomy and SETI need not require the kinds of facilities which only governments can afford. Should NASA in the future receive Congressional approval to resume its SETI activities, signals from the proposed beacon facility will remain available to NASA for the testing and calibration of their Earth-based radio telescopes.

A lunar reflective beacon transmitter can revive a secondary function once performed by the S-band (2290 MHz) Apollo Lunar Science Experiment Package (ALSEP) transmitters placed on the lunar surface by NASA in the 1970s, and now long defunct. The Pioneer 10 spacececraft beacon now fulfills this function for investigators at the Arecibo Observatory, but is currently at the limits of its useful range. The proposed beacon signals will be freely available to all observers worldwide, on a non-discriminatory basis, enabling any observer to ascertain the sensitivity and proper function of his or her radio telescope. The planned test signal will comply with all relevant FCC regulations.

Electromagnetic Interference:

The design of the proposed facility has taken into account the sensitivity and interference threshold of other radio astronomy facilities worldwide, and efforts have been taken to ensure no harmful interference to any such facility will result from the operation of the planned beacon. Letters of support to this effect from cognizant personnel at relevant facilities are enclosed herewith, as requested by AAS Associate Executive Officer Kevin B. Marvel.

Institutional Endowment:

The SETI League, Inc. is an international, membership-supported nonprofit [501(c)(3)] educational and scientific organization, with a total annual budget of $165,000 supporting one full-time and one part-time employee. Its membership base of 1165 members in 59 countries provides 17% of that operating budget. The balance comes from small corporate gifts, foundation grants, and research grants such as this one. Total assets of the Corporation are on the order of $140,000. Thus, The SETI League,

Inc. qualifies as a smaller, less endowed institution, and respectfully requests we be given priority in consideration of this application.

Preliminary Budget:

Total direct and indirect expenses associated with this project are expected to exceed $20,000 US. This grant application respectfully requests $5,000 US for the purchase of required hardware; specifically antennas, transmit equipment and accessories, as follows:

Helix Antennas, four ea. OAL-23RHCP/15 and OAL-23LHCP/15	$1010
Antenna back planes and phasing harnesses, Olde Antenna Labs	$565
Power dividers, two Down East Microwave 23-4PD or similar	$130
Exciter, one K9EK-1296 single-tube cavity amplifier	$325
Power amplifier, one Terrestrial Power Systems 1296-7289/6 or similar	$1700
Power supply, 1700 VDC at 1.7 Amperes, regulated	$800
Antenna Controller, one ea. LL Grace Co. Kansas City Tracker	$230
Preamplifier, Down East Microwave 23LNAH or equivalent	$140
Coaxial T-R Relay, Y-type SPDT with type N connectors, Transco or similar	$100

All additional required funding has already been secured through grants or gifts-in-kind, as delineated in the following Section.

Other Funding Sources:

1. The Principal Investigator's salary and benefits are being paid by a bequest from the Orville Greene Foundation.
2. Office space is being donated by Eventide, Inc.
3. Part-time secretarial support is funded by The SETI League, Inc. through membership dues.
4. The transmit beacon site, transceiver, tower and rotors, control computer, and telecommunications infrastructure are being contributed by Mr. Richard C. Factor.
5. Engineering lab facility rental and construction labor are provided by a grant from the Second Foundation.
6. Required circuit design software has been contributed by Eagleware, Inc.
7. Required microwave test equipment has been donated by Merrimac, Inc.
8. Lunar tracking software has been donated by the Radio Amateur Satellite Corporation (AMSAT).
9. FCC licensing coordination services are being contributed by Stephen D. Carver, Esq.

Timeframe: Construction of the antennas and transmit amplifier for the proposed beacon facility has in fact already begun, funded out of SETI League unrestricted cash reserves. Initial testing will commence six months after receipt of funds requested herein. It is expected that the beacon facility will be fully and continuously operational within thirty days after initial testing commences.

Use of Funds: All funds received from the American Astronomical Society in conjunction with this grant application will be used to replenish SETI League unrestricted discretionary funds currently being expended solely for the purpose stated above. A full accounting will be provided to the AAS within eight months of receipt of funds.

Respectfully Submitted:

H. Paul Shuch, Ph.D.
Principal Investigator, *Project Argus*
Executive Director, The SETI League, Inc.

Approved By:

Richard C. Factor
President, The SETI League, Inc.
1 May 2000