The Reflector Reflector Reflector Reflector Reflector

The Monthly Bulletin of the Oak Ridge Amateur Radio Club, Inc., Oak Ridge, TN – March 2024

April 2024 President's Message Bob Parks W4JRP

Well April has arrived and spring is in the air. We received great news from David Andrews, N1ESK. The East TN Repeater Association has been awarded a grant for area repeater upgrades, and we have funds available for the ORARC repeater relocation efforts. So the project is progressing. Our presentation Monday will be by Phil Hejtmanek on what he has done with his 10 GHz microwave setup. We will have a brief discussion after Phil's presentation about the next steps for the repeater relocation.

I look forward to seeing everyone on Monday.

****

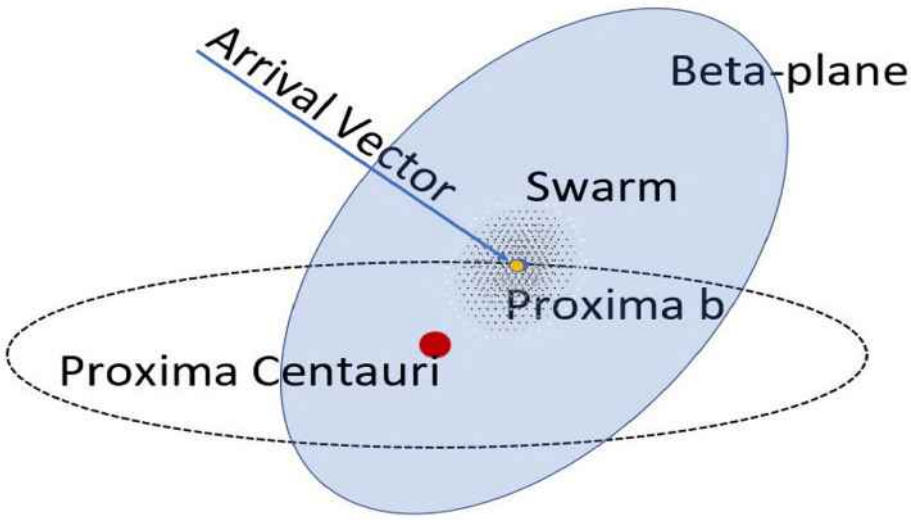
Dan Manooth, ORARC Treasurer, reports. Currently we have received dues from 33 members out of 43 currently on the active member list. It is my expectation based on past experience that this result is unlikely to change in the coming months. That said, if on reading this note, you realize that you are one of the 10 delinquent folks, your dues will be gladly thankfully received. You will or should have already received a reminder from our newsletter editor. Many thanks to those that have paid their dues and are current. If you haven't paid and no longer wish to be active in the Oak Ridge Amateur Radio Club, just let me know and I will remove your name from the active role. I will retain you information in a separate file in the event you wish to renew at some point. Those who are in arrears more than one year, will no longer receive the Reflector each month.

If you have not paid your dues, please either mail us a check or log into the Oak Ridge Amateur Club's website and go to the payment section and you can use the PayPal link.

****

Last month, Robert Kennedy gave us an opportunity to see his exciting program about "Swarms Over Interstellar Distances". Here are a couple articles describing the project which as recently received funding from NASA.

Swarming Proxima Centauri: Coherent Picospacecraft Swarms Over Interstellar Distances



Loura Hall

JAN 04, 2024

ARTICLE

- Graphic depiction of Swarming Proxima Centauri: Coherent Picospacecraft Swarms Over Interstellar Distances
Thomas Eubanks

Thomas Eubanks
Space Initiatives, Inc.

Tiny gram-scale interstellar probes pushed by laser light are likely to be the only technology capable of reaching another star this century. We presuppose availability by mid-century of a laser beamer powerful enough (~100-GW) to boost a few grams to relativistic speed, lasersails robust enough to survive launch, and terrestrial light buckets (~1-sq.km) big enough to catch our optical signals. Then our proposed representative mission, around the third quarter of this century, is to fly by our nearest neighbor, the

potentially habitable world Proxima b, with a large autonomous swarm of 1000s of tiny probes.

Given extreme constraints on launch mass (grams), onboard power (milliwatts), and coms aperture (centimeters to meters), our team determined in our work over the last 3 years that only a large swarm of many probes acting in unison can generate an optical signal strong enough to cross the immense distance back to Earth. The 8-year round-trip time lag eliminates any practical control by Earth, therefore the swarm must possess an extraordinary degree of autonomy, for example, in order to prioritize which data is returned to Earth. Thus, the reader will see that coordinating the swarming of individuals into an effective whole is the dominant challenge for our representative mission to Proxima Centauri b. Coordination in turn rests on establishing a mesh network via low-power optical links and synchronizing probes' on-board clocks with Earth and with each other to support accurate position-navigation-timing (PNT).

Our representative mission begins with a long string of probes launched one at a time to ~0.2c. After launch, the drive laser is used for signaling and clock synchronization, providing a continual time signal like a metronome. Initial boost is modulated so the tail of the string catches up with the head ("time on target"). Exploiting drag imparted by the interstellar medium ("velocity on target") over the 20-year cruise keeps the group together once assembled. An initial string 100s to 1000s of AU long dynamically coalesces itself over time into a lens-shaped mesh network #100,000 km across, sufficient to account for ephemeris errors at Proxima, ensuring at least some probes pass close to the target.

A swarm whose members are in known spatial positions relative to each other, having state-of-the-art microminiaturized clocks to keep synchrony, can utilize its entire population to communicate with Earth, periodically building up a single short but extremely bright contemporaneous laser pulse from all of them. Operational coherence means each probe sends the same data but adjusts its emission time according to its relative position, such that all pulses arrive simultaneously at the receiving arrays on Earth. This effectively multiplies the power from any one probe by the number N of probes in the swarm, providing orders of magnitude greater data return.

A swarm would tolerate significant attrition en route, mitigating the risk of "putting all your eggs in one basket," and enabling close observation of Proxima b from multiple vantage points. Fortunately, we don't have to wait until mid-century to make practical progress – we can explore and test swarming techniques now in a simulated environment, which is what we propose to do in this work. We anticipate our innovations would have a profound effect on space exploration, complementing existing techniques and enabling entirely new types of missions, for example picospacecraft swarms covering all of cislunar space, or instrumenting an entire planetary magnetosphere. Well before mid-century we foresee a number of such missions, starting in Earth or lunar orbit, but in time extending deep into

the outer Solar system. For example, such a swarm could explore the rapidly receding interstellar object 1I/'Oumuamua or the solar gravitational lens. These would both be precursors to the ultimate interstellar mission, but also scientifically valuable in their own right.

****

Swarming Proxima Centauri: Optical Communication Over Interstellar Distances

T. Marshall Eubanks, W. Paul Blase, Andreas Hein, Adam Hibberd, Robert G. Kennedy III

Interstellar communications are achievable with gram-scale spacecraft using swarm techniques introduced herein if an adequate energy source, clocks and a suitable communications protocol exist. The essence of our approach to the Breakthrough Starshot challenge is to launch a long string of 100s of gram-scale interstellar probes at 0.2c in a firing campaign up to a year long, maintain continuous contact with them (directly amongst each other and via Earth utilizing the launch laser), and gradually, during the 20-year cruise, dynamically coalesce the long string into a lens-shaped mesh network ~100,000 km across centered on the target planet Proxima b at the time of fly-by.

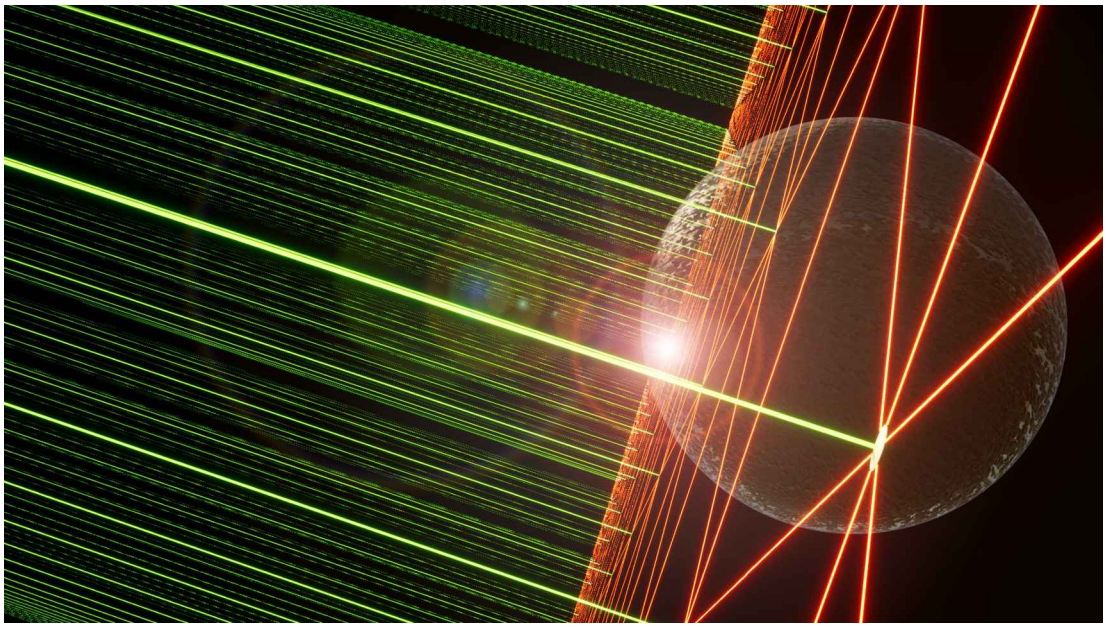
In-flight formation would be accomplished using the "time on target" technique of grossly modulating the initial launch velocity between the head and the tail of the string, and combined with continual fine control or "velocity on target" by adjusting the attitude of selected probes, exploiting the drag imparted by the ISM.

Such a swarm could tolerate significant attrition, e.g., by collisions enroute with interstellar dust grains, thus mitigating the risk that comes with "putting all your eggs in one basket". It would also enable the observation of Proxima b at close range from a multiplicity of viewpoints. Swarm synchronization with state-of-the-art space-rated clocks would enable operational coherence if not actual phase coherence in the swarm optical communications. Betavoltaic technology, which should be commercialized and space-rated in the next decade, can provide an adequate primary energy storage for these swarms. The combination would thus enable data return rates orders of magnitude greater than possible from a single probe.

Comments: Submission to the Breakthrough Starshot Challenge Communications Group Final Report

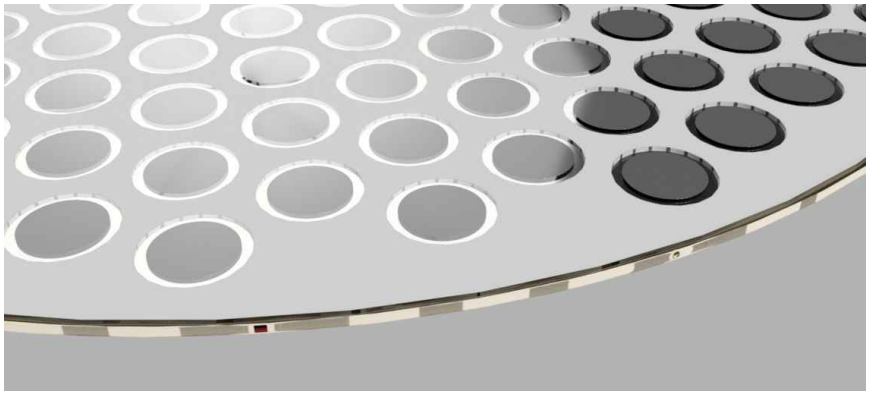
Subjects: Instrumentation and Methods for Astrophysics (astro-ph.IM); Earth and Planetary

Astrophysics (astro-ph.EP); Popular Physics (physics.pop-ph)
Cite as: arXiv:2309.07061 [astro-ph.IM]
(or arXiv:2309.07061v2 [astro-ph.IM] for this version)
https://doi.org/10.48550/arXiv.2309.07061



Probe swarm at the moment of flyby, showing probe-to-probe infrared lasercoms (red) for “operational coherence” and main visible lasercoms back to earth (output blue, doppler-shifted to green on arrival)

Robert Kennedy at NASA Headquarters



Oblique view of the upper surface of a probe, with flat optical wells on metamaterial

****

Robert Kennedy giving his presentation last month

****

CQ CQ CQ CW Operators

Dan Mantooth

A few years ago, there were several members who met regularly on 30 meters to practice sending and receiving CW. No formality just rag chewing or discuss whatever you want. It was just among friends so was a great way for those with “key fright” to dive in and improve their skills. When the organizer of the group moved (Paul, WA4BAG), and COVID hit, the activity died out. I was wondering if there are others out there that would be interested in reviving the practice sessions? Old hands would be welcome to challenge us newbies. If so, shoot me an e-mail at kx4ch@arrl.net and maybe we can get the ball rolling. 73 Dan

****

Art and Dan operating the equipment at the hospital net last month.

****

Jim Womack had another successful event at the recent Sevierville Hamfest.

****

Dan Mantooth loads a trailer with tow pallets of bottled water donated to the American Red Cross in Knoxville. The water was donated by the owner of Barr Technological Services of Oak Ridge

****

Handy ARRL Links

ARRL Home: www.arrl.org

Find help with RF assessments: http://www.arrl.org/rf-exposure

Find an ARRL Affiliated Club: www.arrl.org/clubs

Find your ARRL Section: www.arrl.org/sections

Find a license class in your area: www.arrl.org/class

Find a license exam in your area: www.arrl.org/exam

Find a hamfest or convention: www.arrl.org/hamfests

****

Hamfests and Conventions – save the dates!

April 13, 2024	**Columbus (Indiana) Hamfest**	Columbus, IN
April 20, 2024	**Greeneville TN Hamfest**	http://greenevillehamfest.com/
APRIL 27, 2024	**1st Annual Short Mountain Repeater Club Hamfest, Murfreesboro, TN**	http://www.smrclub.com/
June 15, 2024	**Knoxville Hamfest & Electronics Convention**	http://www.w4bbb.org/
May 17-19, 2024	**Dayton, OH Hamvention**	www.hamvention.org

Regular Meetups and Volunteer Activities

ORARC Club Meeting - every second Monday

Next meeting is April 8 at 7 PM
at the FIRST UNITED METHODIST CHURCH, OAK RIDGE, TN
Board meeting at 6:45 – all are welcome
Contact: Bob Parks, W4JRP, bparks100@gmail.com

ORARC Eatin' Meetin' every Wednesday 11 AM at Shoney's Restaurant, Oak Ridge

For an email reminder for the lunch, write to Willard Sitton at sitton008@outlook.com

Amateur Radio Outreach at the Children's Museum of Oak Ridge (CMOR)

Next session is on **Third Sunday** **(April 21)** of the month, 1-4 PM
Contact: Jim Bogard KY4L, email KY4L@ARRL.NET

Nets

Middle East Tennessee Emergency Radio Service (METERS) – every Monday

Every **Monday** evening at ***7:00 pm*** local time, over the air
WB4GBI 146.94 MHz repeater (-0.6 MHz input offset, 118.8. Hz tone)
Affiliation with ARES or METERS is NOT required to participate.

Clinton Amateur Radio Service (CARS) Weekly Radio Net – every Tuesday

Every **Tuesday** evening at ***8:00 pm***, over the air
147.36 MHz KA4OAK repeater (-0.6 MHz offset, 100.0 Hz tone)

American Red Cross Amateur Net – every Wednesday

Every **Wednesday** evening at ***8:00 pm*** local time, over the air
WB4GBI 147.15 MHz repeater (+600 kHz input offset, 118.8 Hz tone)

Anderson County ARES Net – every Thursday

Every **Thursday** evening at ***7:00 pm*** local time, over the air
WB4GBI 147.15 MHz repeater (+600 kHz input offset, 118.8 Hz tone)

Hospital Net (Meters) – Last Friday of the month at *6:30 pm* local time. In the Homestead room in the Oak Ridge Methodist Hospital.

Club Repeaters

W4SKH 2 meter: 146.97 (-600 kHz input offset, 88.5 Hz tone)
W4SKH 70-cm: 443.200 MHz (+5 MHz input offset CTCSS sub-audible tone 88.5 Hz)
Please test 443.200 to establish its range and power – thanks!

Oak Ridge Amateur Radio Club, Inc.

P.O. Box 4291

Oak Ridge, TN 37831-4291

2022 CLUB OFFICERS

President	Bob Parks W4JRP	(865)-406-4985
Vice-President	Jim Womack KC4RD	(865)-842-7219
Secretary	Jim Bogard KY4L	(865) 806-8069
Treasurer	Dan Mantooth KX4CH	(509) 528-7826
Technical Director	Carl Lyster WA4ADG	(865) 588-7120
Editor	Bob Parks W4JRP	(865) 406-4985
Past President	Jim Womack KC4RD	(865)-842-7219

COORDINATORS

Control Operators	Carl Lyster WA4ADG	(865) 588-7120
	Roy Freeman KE4TG	(865) 482-4474
Education	OPEN	
Field Day	Bob Parks W4JRP	(865) 406-4985
Historian	OPEN	
Public Service	Gwen Cole KF4ROX	(865) 457-1806
Programs	Roy Freeman KE4TG	(865) 482-4474
Trustee-W4SKH	Jim Bogard KY4L	(865) 806-8069
Trustee-K4PJ	Jim Bogard KY4L	(865) 806-8069
ARES Coordinator	Darrell Cook WA4LNX	(865) 207-4827
RACES Coordinator	Darrell Cook WA4LNX	(865) 207-4827
Website Manager	Jamie Wright W4ABE	W4ABE@ARRL.net

Visit our Web Site at www.orarc.net

Club meetings every second Monday are held at the First United Methodist Church in Oak Ridge, TN.
The Reflector is the monthly newsletter of the Oak Ridge Amateur Radio Club, Inc.
The Oak Ridge Amateur Radio Club, Inc. is registered as a 501 (c)(3) Not for Profit Corporation.