Messages from the world's smallest space probe

August 11 2017, by Lisa M. Krieger, The Mercury News

The world's smallest space probe, conceived at Menlo Park's visionary Breakthrough Starshot, has phoned home.

The flying computer chip dubbed "Sprite," the size of a Saltine cracker, is healthy, happy and sending us signals from Earth's orbit, 400 miles from home.

It's still a long way from where its progeny may someday travel: our neighboring star system Alpha Centauri, 24 trillion miles away. The dream is for Sprite-like spacecraft to take close-up images and collect data - maybe even detect gases produced by alien life.

The little Sprite could someday help answer the big questions of life in the Universe: Are we alone? Are there habitable worlds out there? If so, can we reach them?

That's an ambition that will tax the brainpower and bank accounts of its Silicon Valley benefactors, led and funded for the first five years with $100 million donated by internet entrepreneur Yuri Milner. Breakthrough Starshot's board consists of Milner, cosmologist Stephen Hawking of the University of Cambridge and Facebook CEO Mark Zuckerberg.

"But it's very good first step. It's proof of concept," said Breakthrough Starshot director Pete Worden, former director of NASA Ames Research Center, from his office on the valley's storied Sand Hill Road. "It's very exciting."

Scientists now know that planets are as common as a cheap hotel. The

Kepler Space Telescope has identified 2,337, with about 50 in the "goldilocks zone" - not too hot or cold, too big or too small. They're Earth's size and shape and orbit around the warm glow of stars like our own sun, perhaps hosting life.

But here's the problem: It's impossible for humans to travel fast enough, far enough, to reach these distant destinations.

To get there, it would require a spacecraft that moves at a fraction of the speed of light. One huge vessel would take tens of thousands of years to reach Alpha Centauri. But a fleet of tiny Sprite-like probes - if light and small enough - could perhaps succeed.

The project's strategy was reportedly mapped out at a January 2016 gathering at Milner's hilltop mansion joined by Worden, UC Santa Barbara physicist Philip Lubin, Harvard astronomer Avi Loeb and others.

Their mission was energized merely months later, by this startling August 2016 discovery: Earth has a neighbor. The exoplanet Proxima b was discovered at our cosmic doorstep, orbiting Proxima Centauri, the nearest star to our sun. Better yet, the planet is within the so-called "habitable zone," like Earth.

"Finding this planet, Proxima b, was a game-changer," wrote Milner, who studied physics in Moscow and was named after Russian cosmonaut Yuri Gagarin.

It might take a fleet of probes about 20 years to get to Proxima b, then another four years for the data and photos to be beamed back to Earth.

Last April, the team assembled some of the world's experts at Stanford University to discuss the prospects and challenges of travel to Proxima b.

Sprite is the brainchild of Zac Manchester, whose Kickstarter "KickSat" campaign at Cornell University raised the first funds to develop the concept. This month, he joins the faculty of Stanford's Department of Aeronautics and Astronautics. His arrival at Stanford is expected to accelerate the chip satellite effort.

Sprite weighs just four grams, lighter than a quarter. It has its own solar panel, communication capabilities and sensors.

Such tiny spacecraft are possible thanks to rapid advances made in the semiconductor industry, according to Manchester. Most of the features of a traditional spacecraft can be integrated onto a chip-scale device. Sprite is built using the same devices and processes used in the consumer electronics industry.

Spacecraft have been ever-shrinking in size. In the past decade, hundreds of 10-centimeter-sized CubeSats have been launched in space. Manchester's first Sprite effort, with shoebox-sized spacecraft, launched in 2014 but fell out of orbit and burned up.

Sprite has siblings - several Sprites were launched on June 23 - but they've gone incommunicado. They don't fly on their own; they're piggybacking on two satellites.

The one researchers hear is broadcasting a standard radio signal, charging its batteries with sunlight. News came of its signal late last month, via a Cornell ground station. (Amateurs can also listen in; Manchester's KickSat offered a design and instructions for a low-cost and portable Sprite receiving station. Consisting of a hand-held antenna, low-noise amplifier, low-cost USB radio receiver dongle, it can be built for about $200, plus a PC to run the software.)

Eventually, Sprite must be even smaller and lighter. It will weigh less

than one gram, and be fitted with a sail. Carrying its own fuel would add too much weight.

In principle, its sails would be pushed through space by a laser - or an array of lasers - which could create a "wind" of photons, acting like a giant fan. The laser would deliver 100-billion watts of energy, vastly more powerful than the typical 1 milliwatt laser pointer. Directed from Earth, the laser would aim to propel the spacecraft to speeds at 20 percent of the speed of light. That's more than 100 million miles an hour.

There's yet another hurdle: Communication. Worden said the team will work towards building an on-board small optical laser that could turn around, point towards Earth, and communicate via laser, not radio, signals.

"The key thing is the communications, over hundreds of thousands of miles," he said. "That is the challenge."

In September, Breakthrough Starshot will start seeking proposals for a laser device. By next year, it will organize a team to research and design better communication systems.

Then these tiny spacecraft wouldn't send mere "I am here" signals, like Sprite is saying today.

Instead, they could say: "Wow - check out the neighborhood!"