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NEWS RELEASE

To find small asteroids that could hit Earth, private foundation embraces small satellites

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Last week, an asteroid the size of Egypt's Great Pyramid of Giza whizzed by Earth, missing it by half the distance to the moon. The concern that we may one day not be so lucky has long preoccupied the B612 Foundation, a private organization in Mill Valley, California, dedicated to finding asteroids that cross Earth's orbit and could devastate humanity. B612 itself had a near-death experience 3 years ago, when its bold plans for an asteroid-hunting space telescope fell apart. But now, its ambitions are rising again with a new technique for finding menacing objects.

On 10 May, B612 announced a partnership with York Space Systems, a Denver-based maker of standard 85-kilogram satellites, to investigate building a fleet of small asteroid hunters. For many years, B612—which takes its name from the asteroid home of Antoine de Saint-Exupéry's Little Prince—aimed to build and launch a much larger craft, Sentinel, a $450 million space telescope with a 50-centimeter mirror. In 2012, NASA agreed to provide logistical support. But fundraising stalled and, in 2015, the agency ended its agreement with B612 because it wasn't meeting mileposts, essentially killing the telescope. Now, B612 has developed a new technique to do the same thing at a far lower cost with small space telescopes. Ed Lu, B612's co-founder, expects the first telescope to cost about $10 million and believes a full constellation "would be a factor of many, many cheaper" than Sentinel.

Some asteroid astronomers are skeptical of the new approach, saying the technology is far from proven. "To be very, very blunt, what they are proposing and what they've demonstrated is not going to help us find more NEOs [near-Earth objects]," says astronomer Timothy Spahr, CEO of space consultancy firm NEO Sciences in Marlborough, Massachusetts, who does independent work for NASA.

Astronomers believe they have already discovered 95% of the NEOs of civilization-ending size, a kilometer or more across. But ones between 140 meters and 1 kilometer across—still big enough to wipe out a city—are so faint that an estimated 59% remain undiscovered. Finding them, and perhaps developing plans for diverting threats, requires a big telescope, like Sentinel, or long exposures on a smaller one. But if the asteroids are moving fast, they shift from pixel to pixel on the telescope's camera, and the long exposures provide little benefit.

In 2013, astronomer Michael Shao of the Jet Propulsion Laboratory (JPL) in Pasadena, California, and his colleagues outlined a technique called synthetic tracking, which gets around this issue by taking up to 100 snapshots in a single second. A dim asteroid won't appear in any particular image, but by arranging and stacking the photos in thousands of combinations, the system can get lucky and preferentially brighten an unknown fast-moving object.

ON THE HUNT

Congress has tasked NASA with finding 90% of near-Earth asteroids bigger than 140 meters. Most of the biggest are known. Organizations like the B612 Foundation are trying to make progress on smaller ones.
(GRAPH) J. YOU/SCIENCE; (DATA) PAUL CHODAS/JET PROPULSION LABORATORY
Doing this for an unknown asteroid of unknown brightness and speed at an unknown point in the sky is computationally demanding. But Shao says advanced processing power makes it feasible. He adds that the technique would help a small telescope do as good a job as a bigger one, even though it gathers less light. It could also help uncover the fastest moving asteroids, such as the object ‘Oumuamua, an interstellar asteroid spotted zipping through the solar system last year.

Shao and his team simulated how nine 20-centimeter telescopes in orbit around the sun would fare with the technique. In a 2015 study, they projected that the constellation could discover 90% of Earth-grazing asteroids 50 meters or larger in diameter in 5 years, three times faster than other techniques and faster than Sentinel itself. Shao says within a week of publishing his paper, B612 contacted him.

Last year, B612 tested the technique in space by asking the Earth-observing company Planet to turn one of its SkySat satellites around and aim its 35-centimeter telescope at already known asteroids. By applying synthetic tracking, the team could tease out images of the faint objects.

Now, B612 needs to raise money for its new plan. But the asteroid-hunting field is becoming more crowded. Starting in 2021, the Large Synoptic Survey Telescope, an enormous 8.4-meter observatory in Chile, will photograph large parts of the sky each night and could increase the number of known NEOs from about 18,000 to more than 100,000. NASA would also like to build the Near-Earth Object Camera (NEOCam), a space-based mission that would

replicate many of Sentinel's goals and abilities. Although the mission was not selected in a competition last year, it was given money for continued study, a sign that it might one day fly.

Lindley Johnson, NASA's planetary defense officer in Washington, D.C., says NEOCam could launch 4 years after it's given the go-ahead, and that it would likely be better at finding asteroids than B612's constellation. He says synthetic tracking is good for detecting fast-moving objects near Earth, like debris and satellites, but won't work as well for faint and distant objects. "I think they are overoptimistic in their assessments," he says. Shao, however, says experts at JPL have assured him that small satellites can provide the power, computation, and communications needed for synthetic asteroid tracking to work.

Mark Sykes, CEO and director of the Planetary Science Institute in Tucson, Arizona, says any of these asteroid missions could pay off for research as well as for planetary protection. Spotting asteroids passing closer than the moon, like the 15 May object, would allow researchers to explore at close range objects that hail from the distant solar system. "We would have a one-stop shopping center for sampling material that has formed throughout the solar system," he says, adding that asteroid mining companies would also be interested in such near-Earth targets.

Lu shares those hopes. He wants B612 to compile nearby asteroids in a user-friendly catalog, like a Google Maps for the solar system—a step that he says would help future scientists, explorers, and miners. "If you buy into the idea that humans will someday live and work and economically operate in space, then you need a map," he says.

*Correction, 23 May, 5 p.m.: Ed Lu's role at B612 has been clarified.