These space rocks could save the planet

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LLNL researcher Megan Bruck Syal examines a pair of meteorites destined to be vaporized by high-powered lasers. Credit: Julie Russell/LLNL

The box was inconspicuous, but Lawrence Livermore National Laboratory (LLNL) postdoctoral researcher Megan Bruck Syal immediately knew its contents: two meteorites around the size of walnuts. They formed about 4.6 billion years ago and survived a history of violent collisions in the asteroid belt before being bumped into a near-

Earth-object orbit by gravitational interactions with the planets.

After finally raining down on Earth, these rocks were scavenged in Antarctica by researchers, sorted and classified at NASA Johnson Space Center, then mailed first-class to Bruck Syal.

Now that these space rocks are in Bruck Syal's hands, they are mere months away from fulfilling their destiny. They are to be vaporized by a high-powered laser, and the data they yield on asteroid deflection could one day save the planet.

"It's not a matter of if, but when," Bruck Syal said, referring to the eventual certainty of a large celestial object impacting the Earth. "Our challenge is to figure out how to avert disaster before it happens."

So far, NASA (link is external) has identified 14,000 near-Earth objects – a number growing by more than 1,500 per year – and calculated the probability of impact for each. Included in that group are more than 1,600 "potentially hazardous asteroids" that come within 20 times the moon's distance to the Earth. But even with all these objects mapped, it doesn't do any good to see the catastrophe coming if nothing can be done to avert it.

Defending the planet with science

Bruck Syal is a member of the Laboratory's small planetary defense team, a group of physicists, material scientists, engineers and computational researchers working with NASA, Los Alamos and Sandia national labs and collaborators across a number of universities and international research centers. The challenge facing this international coalition of scientists is to detect and deflect the next large Earth-bound object.

This program is one of dozens of research efforts that grew out of the capabilities and expertise developed and honed in Lawrence Livermore's weapons program, and an example of how the Laboratory is using science and technology to make the world a safer place.

Over the years, the team has focused its research on two principle methods of asteroid deflection: nuclear explosions and hypervelocity projectiles. The goal isn't to destroy inbound space objects, but rather to nudge their trajectory just enough to make them miss. But it's exceedingly difficult to be certain how best to deflect an asteroid, and even more difficult to be certain that it will work at the Earth's most urgent moment.

"Each comet and asteroid has its own unique character, which presents a challenge for predicting how an individual target would respond to a deflection attempt," Bruck Syal explained. "The makeup may vary significantly from asteroid to asteroid. An individual body may have an abnormal orbit or rotation, and its size would also affect which method we might use to deflect it."

Preparing samples for destructive evaluation

Space rocks aren't like most laser targets. They tend to be much more heterogeneous, often containing chondrules, pebbly inclusions that were melted early in solar system history and embedded in a matrix of finer-grained material. It's this heterogeneous nature that makes it difficult to obtain the experimental data that will ultimately inform how best to deflect an incoming asteroid.

"There's very little known about asteroid strength," Bruck Syal said. "We're doing everything we can to know more about how asteroid materials respond under extreme conditions."

The final days of these space rocks will be busy. Bruck Syal is teaming up with Laura Chen, a postdoctoral researcher at the University of Oxford (link is external). Chen is analyzing data from recent experiments to help determine what sort of laser pulses to use to extract the data they need from the rocks. The team also needs to get the right set of diagnostics in place to capture the data.

All the while, Bruck Syal will send the rocks across the one-square-mile Laboratory to one of the last remaining master opticians on Earth, who will cut and polish the space rocks down to thicknesses of tens to hundreds of microns, with sub-micron variances across the samples.

Come fall, they will be mounted inside the target chamber at LLNL's Jupiter Laser Facility, a countdown will ensue, and months of preparation will come down to a nanosecond laser pulse, sending a haymaker shockwave through the samples. It is at this moment, when they are vaporized and converted into data, that they will have fulfilled their destiny.

Provided by Lawrence Livermore National Laboratory

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