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Space

Asteroid hit by NASA spacecraft is behaving unexpectedly

Jonathan O'Callaghan

A HIGH school teacher and his students have discovered that an asteroid struck by a probe, in a test run for saving Earth should a collision one day threaten us, is behaving unexpectedly. The find could have implications for future planetary defence missions.

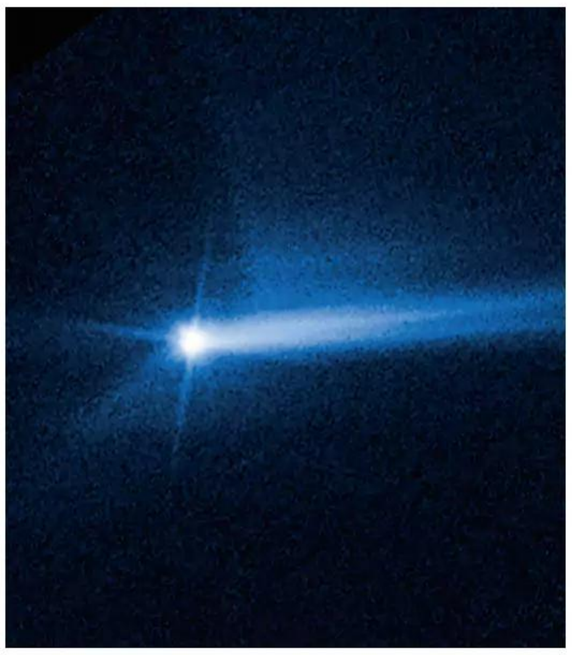
On 27 September 2022, NASA intentionally crashed its Double Asteroid Redirection Test (DART) vehicle into the asteroid Dimorphos. The goal was to slow the space rock's nearly 12-hour orbit around a parent asteroid, called Didymos, and see if the momentum of the spacecraft could alter the asteroid's trajectory. The mission was successful, with Dimorphos's orbit shortening by 33 minutes in the weeks after the impact.

Teacher Jonathan Swift at Thacher School in California and his students used the observatory there to follow up the findings. The school's 0.7-metre telescope was powerful enough to observe these distant objects, and they found that the orbit of Dimorphos had shrunk by another minute more than a month after the collision (arXiv, doi.org/ksxf). "The number we got was slightly larger, a change of 34 minutes," says Swift. "That was inconsistent at an uncomfortable level."

His team presented its findings at a meeting of the American Astronomical Society in New Mexico in June.

The observations suggest something has caused the orbit of Dimorphos to continuously slow since the impact. One possibility is that the asteroid is now tumbling, having previously been tidally locked to Didymos. "That could cause tidal forces to change the orbital period," says Swift.

Harrison Agrusa, a DART team member at the Côte d'Azur Observatory in France, says there is some evidence for tumbling. "After the impact, it's significantly librating," he says, meaning that Dimorphos is wobbling in its position relative to Didymos,



NASA/ESA/STSCI/HUBBLE

Dimorphos after its collision with the DART mission

like the moon does with Earth. "Then it's possible, depending on inertia, this would evolve into more chaotic tumbling where it can flip around," he says.

However, Agrusa says this tumbling is unlikely to cause a shortening of Dimorphos's orbit, as the orbit would instead vary randomly. It is more likely that big rocks kicked up by the impact stayed in orbit near Dimorphos and later fell back to the surface, slowing its orbit more, he says.

Nancy Chabot, the coordination lead on DART at Johns Hopkins Applied Physics Laboratory in Maryland, says the DART team has continued to observe Dimorphos and will publish its own results in the coming weeks. Those also show the orbital period continued to decrease, albeit by a lesser amount, some 15 seconds, before plateauing, perhaps supporting the idea of ejected material continuing to hit the surface.

An upcoming European Space Agency mission called Hera, set to arrive at Dimorphos in 2026, could tell us for certain what happened after the impact, which may have implications for future attempts to redirect an asteroid.

"It's really good to know what we did to Dimorphos," says Chabot. "Those specific details are really key to applying this technique in future." ▮

Archaeology

Terracotta Army reveals secrets of ancient footwear

SHOES worn by the warriors of the first emperor of China, famously depicted by the Terracotta Army, may have been surprisingly flexible and slip resistant. Replicas of them are helping to build a better picture of what Qin dynasty soldiers wore and how this might have aided them in battle.

The Terracotta Army was found in 1974 near Xi'an, China, and is formed of more than 8000 sculptures depicting the armies of the founder of the Qin dynasty, Qin Shi Huang. The terracotta figures include warriors, chariots and horses and were buried alongside the emperor more than 2200 years ago to guard him in the afterlife.

Analysis of the sculptures has revealed what armour the ancient Chinese warriors wore and what weapons they used. Now, Na Cha and Jin Zhou at Sichuan University in China have recreated the shoes of one of the army's kneeling archers.

DAVID DAVIS/ALAMY

A kneeling archer from the sculpture army buried with emperor Qin Shi Huang

The pair determined that the archer's square-toed shoes had upturned tips and their soles were about 1.5 centimetres thick. There were also circular markings on the bottom of the soles, which the researchers took to represent stitches. There were more circles at the front and the heel, hinting that the real shoe was thinner in the middle, say Cha and Zhou.

The terracotta shoes resembled real shoes unearthed from the Qin dynasty, so the researchers used traditional shoe-making techniques from the time to recreate them.

They constructed the sole by overlaying layers of linen cloth and sewing them together using a fibre called ramie, which also made up the body of the shoes. They used denser stitches in the top and bottom thirds of the sole to replicate the circular markings.

The researchers also created replicas of other shoes found in the region and wore both types to test them. They found that the army replicas were more likely to bend during walking and were more slip resistant than the others. They were also more slip resistant in wet conditions than modern shoes with rubber or plastic soles (Research Square, doi.org/ksjj).

If the replica shoes truly reflect the real ones, they would probably have enhanced the soldiers' combat abilities, say Cha and Zhou. ▮

Chen Ly