A NASA mission that collided with an asteroid didn't just leave a dent. It reshaped the space rock

February 27 2024, by Ian Whittaker

Credit: NASA/Johns Hopkins APL/Steve Gribben

A frequent idea in sci-fi and apocalyptic films is that of an asteroid striking Earth and causing global devastation. While the probabilities of this kind of mass extinction occurring on our planet are incredibly small, they are not zero.

The results of Nasa's Dart mission to the asteroid Dimorphos have now been published in *Nature Astronomy*. They contain fascinating details about the composition of this asteroid and whether we can defend Earth against incoming space rocks.

The Double Asteroid Redirection Test (Dart) was a spacecraft mission that launched in November 2021. It was sent to an asteroid called Dimorphos and commanded to collide with it, head on, in September 2022.

Dimorphos posed and poses no threat to Earth in the near future. But the mission was designed to see if deflecting an asteroid away from a collision course with Earth was possible through "kinetic" means—in other words, a direct impact of a human-made object on its surface.

Asteroid missions are never easy. The relatively small size of these objects (compared to planets and moons) means there is no appreciable gravity to enable spacecraft to land and collect a sample.

Space agencies have launched a number of spacecraft to asteroids in recent times. For example, the Japanese space agency's (Jaxa) Hayabusa-2 mission reached the asteroid Ryugu in 2018, the same year Nasa's Osiris-Rex mission rendezvoused with the asteroid Bennu.

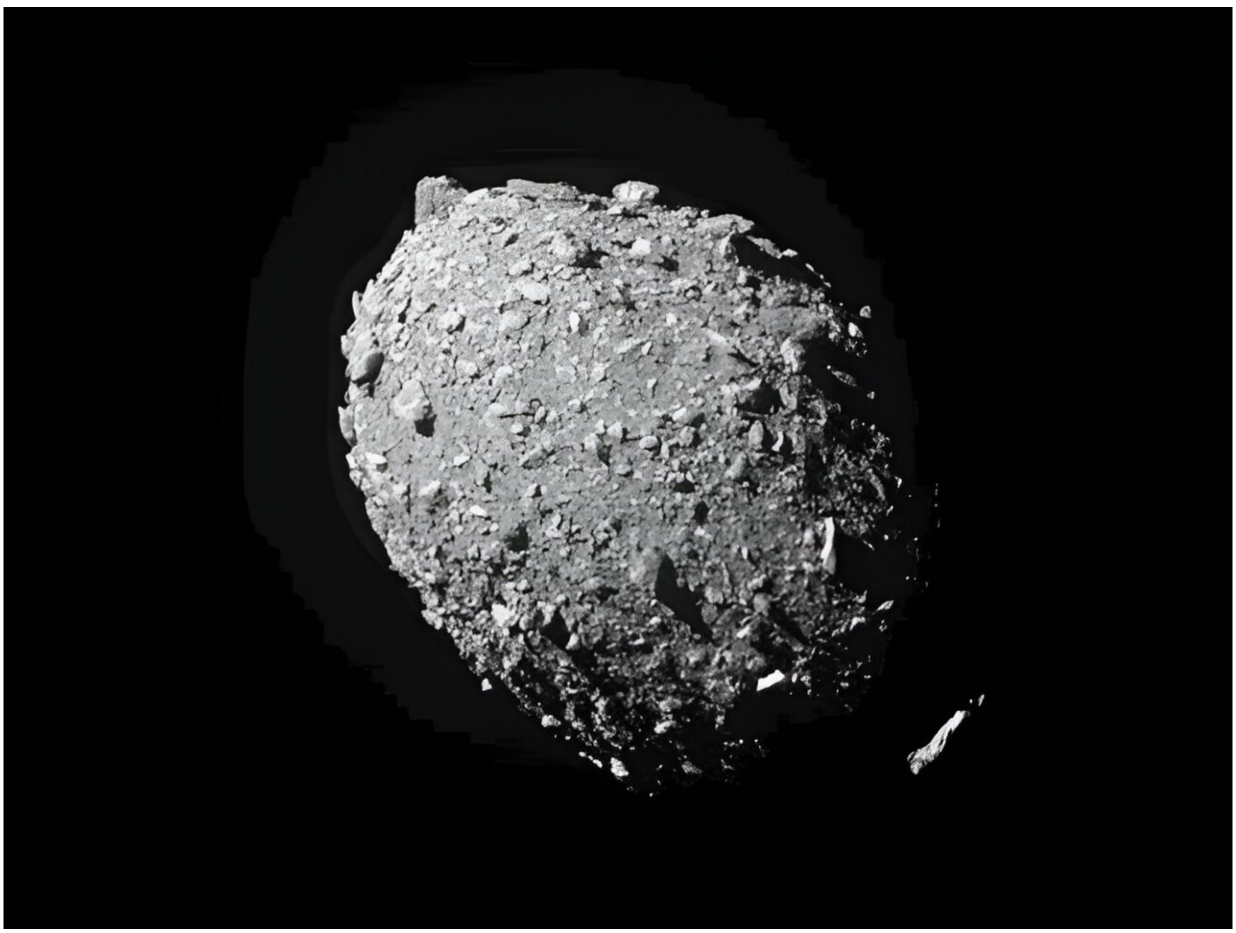
The Japanese Hayabusa missions (1 and 2) fired a small projectile at the surface as they approached it. They would then collect the debris as it flew by.

High-speed collision

However, the Dart mission was special in that it was not sent to deliver samples of asteroid material to labs on Earth. Instead, it was to fly at high speed into the space rock and be destroyed in the process.

A high-speed collision with an asteroid needs incredible precision. Dart's target of Dimorphos was actually part of a double asteroid system, known as a binary because the smaller object orbits the larger one. This binary contained both Didymus—the larger of the two objects—and Dimorphos, which behaves effectively as a moon.

The simulations of what has happened to Dimorphos show that while we might expect to see a very large crater on the asteroid from Dart's impact, it is more likely that it has, in fact, changed the shape of the asteroid instead.



Dimorphos, as pictured by the Dart spacecraft. Credit: NASA

Ant hitting two buses

The collision was of a mass of 580kg hitting an asteroid of roughly 5 billion kg. For comparison, this is equivalent to an ant hitting two buses. But the spacecraft is also traveling around 6 kilometers per second.

The simulation results based on observations of the asteroid Dimorphos have shown that the asteroid now orbits around its larger companion, Didymus, 33 minutes slower than before. Its orbit has gone from 11 hours, 55 minutes to 11 hours, 22 minutes.

The momentum change to the core of Dimorphos is also higher than one would predict from the direct impact, which may seem impossible at first. However, the asteroid is quite weakly constructed, consisting of loose rubble held together by gravity. The impact caused a lot of material to be blown off of Dimorphos.

This material is now traveling in the opposite direction to the impact. This acts like a recoil, slowing down the asteroid.

Observations of all the highly reflective material that has been shed from Dimorphos allows scientists to estimate how much of it has been lost from the asteroid. Their result is roughly 20 million kilograms—equivalent to about six of the Apollo-era Saturn V rockets fully loaded with fuel.

Combining all the parameters together (mass, speed, angle and amount of material lost) and simulating the impact has allowed the researchers to be fairly confident about the answer. Confident not only regarding the grain size of the material coming from Dimorphos, but also that the asteroid has limited cohesion and the surface must be constantly altered, or reshaped, by minor impacts.

But what does this tell us about protecting ourselves from an asteroid impact? Significant recent impacts on Earth have included the meteor which broke up in the sky over the city of Chelyabinsk, Russia, in 2013, and the infamous Tunguska impact over a remote part of Siberia in 1908.

While these were not the kinds of events that are able to cause mass extinctions—like the 10km object that wiped out the dinosaurs when it struck our planet 66 million years ago—the potential for damage and loss of life with smaller objects such as those at Chelyabinsk and Tunguska is very high.

The Dart mission cost US$324 million (£255 million), which is low for a space mission, and with its development phase completed, a similar mission to go and deflect an asteroid heading our way could be launched more cheaply.

The big variable here is how much warning we will have, because a change in orbit of 30 minutes—as was observed when Dart struck Dimorphos—will make little difference if the asteroid is already very close to Earth. However, if we can predict the object path from further out—preferably outside the solar system—and make small changes, this could be enough to divert the path of an asteroid away from our planet.

We can expect to see more of these missions in the future, not only because of interest in the science surrounding asteroids, but because the ease of removing material from them means that private companies might want to step up their ideas of mining these space rocks for precious metals.

More information: S. D. Raducan et al, Physical properties of

asteroid Dimorphos as derived from the DART impact, *Nature Astronomy* (2024). DOI: 10.1038/s41550-024-02200-3

Provided by The Conversation

Citation: A NASA mission that collided with an asteroid didn't just leave a dent. It reshaped the space rock (2024, February 27) retrieved 27 April 2024 from https://phys.org/news/2024-02-nasa-mission-collided-asteroid-didnt.html