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HOW NASA DEFLECTED AN ASTEROID BY CRASHING A SPACECRAFT INTO IT

NASA's DART spacecraft made impact with its asteroid target on 27 September. **Dr Tim Gregory** tells us about this first-of-its-kind mission

WHAT IS THE DART MISSION?

It stands for the Double Asteroid Redirection Test. It's essentially a big science experiment to see if crashing a spacecraft into an asteroid is a good way to change its orbit around the Sun and potentially deflect an Earth-crossing asteroid away, should that happen in the future… or rather *when* that happens.

TELL US ABOUT THE SPACECRAFT.

DART is quite a hefty spacecraft. It weighs more than half a tonne, at 610 kilograms. One of my favourite things about this mission is that onboard is a CubeSat [LICIACube, or Light Italian CubeSat for Imaging Asteroids]. CubeSats are little, miniature satellites about the size of a champagne bottle. This particular CubeSat is Italian in origin and it's got a camera.

WHY WAS THE DIDYMOS BINARY ASTEROID SYSTEM SELECTED AS THE TARGET FOR THE MISSION?

The double asteroid is a cool little system. Much like the Earth has a celestial companion with the Moon, some asteroids have celestial companions, too. We call them binary asteroids. The target is made up of two individual objects: Didymos A, which is about 780 metres across, that's roughly seven football pitches; and its smaller companion Dimorphos, which is 160 metres across. The DART mission targeted the smaller of the two, Dimorphos.

It's important to stress that this particular asteroid system doesn't pose a threat to the Earth. It was merely chosen as a target based on its orbit around the Sun. It's got a very well-determined orbit and we will be able to track the new orbit to see if it's changed.

One of the really mind-blowing things about these asteroids is that we don't actually know a lot about them, other than their orbital parameters. We don't know what they look like. We don't know exactly what they're made of. And that's actually true, for basically every single asteroid in the Solar System.

HOW BIG WOULD AN ASTEROID HAVE TO BE TO DO SERIOUS DAMAGE TO THE EARTH?

An asteroid with a diameter of 300 metres, so about the size of the Eiffel Tower, strikes the Earth approximately every 80,000 years, and that releases the same amount of energy as 50 hydrogen bombs being detonated simultaneously.

There are around 900 potentially hazardous asteroids that are more than one kilometre across. If one of those hit our planet, it would be the same as almost 2,000 hydrogen bombs' worth of energy. On a local scale, that would be devastating. It's worth noting as well that the dinosaurs went extinct when an asteroid hit the Earth 66 million years ago. But that was a pretty big asteroid that was about 20 kilometres across.

WHY IS THIS METHOD OF DEFLECTION CALLED 'KINETIC IMPACT'?

Kinetic impact is essentially what it says on the tin. It is slamming a spacecraft into an asteroid to ever-so-slightly nudge its orbit around the Sun, away from the Earth. It sounds impossible that something as lightweight as a spacecraft, even a spacecraft like DART that weighs more than half a tonne, could possibly nudge something like an asteroid, which weighs millions of tonnes. But you don't need to nudge an asteroid by very much for it to miss the Earth entirely.

These things are not travelling in straight lines towards the Earth, or at least if we found an asteroid heading towards the Earth it wouldn't be

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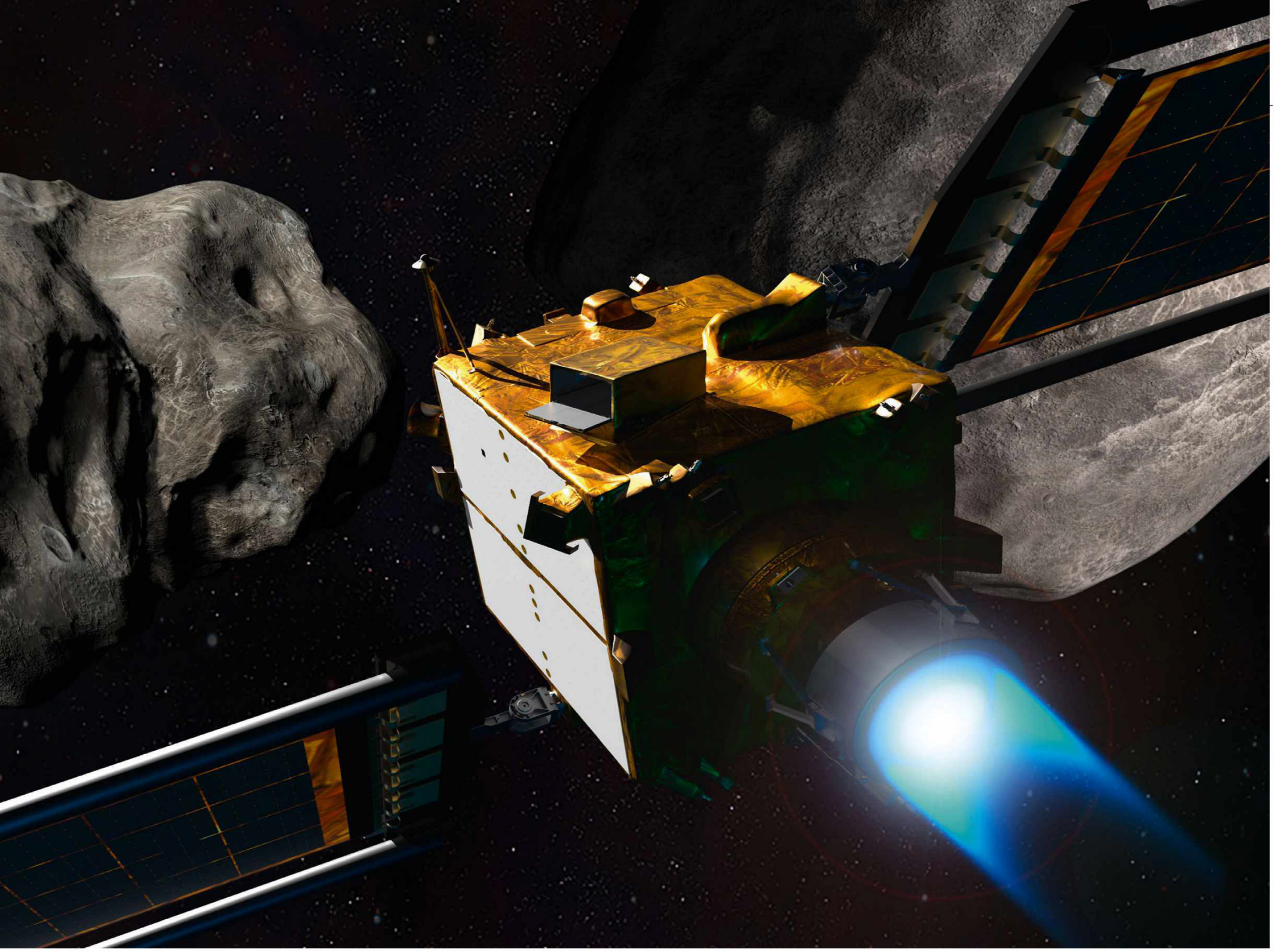

“It sounds impossible that something like DART could possibly nudge something like an asteroid”

travelling in a straight line. They are in orbit around the Sun, along with the planets, including the Earth. You don’t have to nudge that trajectory around the Sun by very much. Just alter its path by fractions of a degree and you’ll miss the Earth by millions of miles.

In summary, kinetic impact is slamming a spacecraft into an asteroid to try and deflect it.

THE ASTEROID SYSTEM IS MORE THAN 10 MILLION KILOMETRES FROM EARTH. HOW DID THE SCIENTISTS NAVIGATE THE SPACECRAFT TOWARDS THE ASTEROID?

We can track asteroids pretty well from the surface of the Earth using ground-based telescopes. DART has got an onboard camera that was directed onto the asteroid.

NOW THE COLLISION HAS TAKEN PLACE, HOW WILL WE ESTABLISH HOW SUCCESSFUL THE MISSION HAS BEEN?

Well, we’re not exactly sure what’s going to happen. There are computer models that have been run that will predict how much this asteroid will be deflected. And there will be predictions about the new orbits of the asteroid after impact. I guess exactly how closely the observational data matches with those models will tell us how much of a success it has been.

But even if this mission doesn’t match the models in the predictions, it will still be a success. The nature of doing any sort of science is sometimes you just don’t know what’s going to happen. And with this mission being the first of its kind, I think the margin for success is very wide. To paraphrase the Apollo astronauts, hopefully it will be a success, but it might be a very successful failure.

DR TIM GREGORY

Tim is a science communicator with a PhD in cosmochemistry. He is the author of Meteorite: The Stones From Outer Space That Made Our World *(£10.99, John Murray).*