NASA's DART Targets Twins for Asteroid Defense

By John F. Kross

Taking a page from a science fiction movie script, NASA has approved a mission to deflect an asteroid to further planetary defense. The mission, dubbed the Double Asteroid Redirection Test (DART), takes aim at an intermediate-size object that could cause regional damage if it collided with Earth. "DART would be NASA's first mission to demonstrate what's known as the kinetic impactor technique—striking the asteroid to shift its orbit—to defend against a potential future asteroid impact," said Lindley Johnson, planetary defense officer at NASA headquarters. To acquire the know-how needed to tackle potential threats, NASA created the Planetary Defense Coordination Office (PDCO) in 2016 to ramp up the tracking and characterization of potentially hazardous objects and coordinate a response. In concert, the U.S. space agency approved the promotion of DART from concept development to the preliminary design phase in June 2017.

Weighing 500 kilograms, the refrigerator-size DART spacecraft would target a binary asteroid system called Didymos (Greek for "twin") composed of a larger asteroid, Didymos A, about 780 meters in size, and Didymos B, its 160-meter wide sidekick. Only Didymos B would be in DART's crosshairs as the twins make a distant approach (10.9 million kilometers) from Earth in 2022 and 2024. After launch, DART would fly to the binary system using its targeting system to zero in on Didymos B, most likely in 2024. "A binary asteroid is the perfect natural laboratory for this test,"said Tom Statler, program scientist for DART at NASA. "The fact that Didymos B is in orbit around Didymos A makes it easier to see the results of the impact."

DART would slam into the space rock about nine-times faster than a bullet—six kilometers per second—allowing Earth-based observatories to see the crash and shift in the orbit of Didymos B around its larger twin. "We intend to… change the orbital period of Didymos… seven minutes or more… and we will be able to see that from the ground," predicted Cheryl Reed, DART's project manager at the Johns Hopkins University Applied Physics Laboratory (JHUAPL).

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The sudden impact would change the mutual orbit of the two objects, but cause only a minor shift in the heliocentric orbit of the system. Although the Didymos twins pose no threat, in principle, even a small nudge to a menacing asteroid could change its speed and trajectory enough to miss our planet.

"DART is a critical step in demonstrating we can protect our planet from a future asteroid impact," explained DART investigation team coleader, Andy Cheng at JHUAPL. "With DART, we can show how to protect Earth from an asteroid strike with a kinetic impactor by knocking the hazardous object into a different flight path that would not threaten the planet."

About 100 tons of cosmic material falls onto the Earth daily, mostly in the form of harmless dust and small meteorites that break up in the atmosphere.

Most of the 1,000 or so near-Earth asteroids large enough to cause a global disaster have been spotted and tracked. However, far less is known about intermediate-size asteroids

▲ 1. More information is needed to defend against intermediate-size asteroids that could cause severe regional damage to our planet. Image credit: ESA - P.Carril

▲ 2. An artist's concept of the DART mission to intentionally strike the binary asteroid system called Didymos (Greek for "twin") and test planetary defense. Image Credit: ESA

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that could cause severe regional damage to our planet. "Since we don't know that much about their internal structure or composition, we need to perform this experiment on a real asteroid," said Andy Cheng at Johns Hopkins University Applied Physics Laboratory (JHUAPL).

Autonomous Navigation and Ion Thrusters

The DART (Double Asteroid Redirection Test) spacecraft features a simple single string design and thruster-only control, but carries sophisticated instruments and propulsion technologies. On board, a high-resolution imager derived from the New Horizons LORRI camera, called the Didymos Reconnaissance and Asteroid Camera for Op-Nav (DRACO), would support navigation and pinpoint the impact site in geologic context. As a technology demonstration mission, DART would also integrate advanced technologies such as electric propulsion and autonomous navigation. Precise, self-directed navigation is required to ensure the accuracy of the kinetic impact. In addition, the autonomous system would test fuel management logic software to tweak the timing of course corrections and optimize the limited fuel onboard.

DART would steer to its violent rendezvous using the NASA Evolutionary Xenon Thruster-Commercial (NEXT-C) solar electric propulsion system, a more advanced and powerful version of the ion thruster used on the Dawn spacecraft. Electric propulsion provides greater flexibility to DART's mission timeline and launch window, as well as decreases launch costs. DART could ride as a shared payload on a commercial rocket carrying a communications satellite and be inserted into a geostationary transfer orbit before thrusting its ion engine toward Didymos.

Originally, the DART project, a joint effort between NASA and the JHUAPL, was a complementary part of the Asteroid Impact and Deflection Assessment (AIDA) mission in collaboration with the European Space Agency (ESA) and the German Aerospace Center. ESA agreed to build a separate Asteroid Impact Mission (AIM) spacecraft to orbit the asteroid pair and observe DART's impact. However, in late 2016, the AIM probe was defunded by ESA to help pay for ExoMars and other projects. European space officials are still weighing a future role for a scaled-back, cheaper version of the AIM mission called AIMlight. Despite AIDA's abrupt finale, DART gained approval from NASA as a solo mission, though it is not a specific budget item in the Fiscal Year 2018 budget. If fully funded, however, DART would be the first off-world demonstration of planetary defense, just in case the sky really does fall one day.