SAMPLE

Solar System Missions: DART

Deflecting an Asteroid

Aira Astralis

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Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

DART is the spacecraft humanity deliberately crashed into an asteroid to learn how to defend the planet. The Double Asteroid Redirection Test, launched by NASA on 24 November 2021 and flown by the Johns Hopkins Applied Physics Laboratory, was the first mission built to move a celestial body on purpose, and on 26 September 2022 it struck Dimorphos, the small moon of the asteroid Didymos, at nearly seven kilometers per second, changing the moonlet's orbit by more than half an hour and proving, for the first time, that a spacecraft can deflect an asteroid.

The mission's logic was a careful assemblage of answers to the questions a deflection test raises. How do you practice moving an asteroid without endangering anyone? Choose a binary system that never comes close to Earth, and shift the orbit of the small moon around its parent rather than the orbit of anything around the Sun, so the experiment is contained. How do you measure a success you cannot watch? A telescope network on every continent watched the eclipse timing of the binary before and after, so the orbit's change, the mission's whole result, was measured from the ground within days. And how do you turn a single collision into science? Ride along a small Italian cubesat that photographed the impact's ejecta, aim the world's observatories at the debris, and let the impact, one afternoon in September 2022, become a years-long research program.

This book tells the story in full: the planetary-defense thinking that created the mission, the spacecraft's design and its autonomous navigation, the launch and the long approach to a target the spacecraft would meet for a single second, the impact itself and the world's response, the results, the orbit change, the ejecta, the reshaping of the moonlet, and the follow-on mission that is already flying to inspect the crater. DART is the first mission whose success was a collision, and the chapters ahead are the account of the moment humanity nudged a world on purpose and the science that followed.

A note on the mission's evidence, before the story begins: the account in these chapters rests on the mission's public record, the impact papers and the observation campaigns, the results published in the open literature, and the numbers quoted, the period change, the beta, the masses and speeds, are the mission's own, stated with their uncertainties where the science is still at work. The chapters keep the record's honesty because the mission itself set the standard, a demonstration conducted in the open, measured by the world, and published to everyone, the way a species' first act of planetary defense should be.

The chapters ahead follow the arc in order: the discovery and understanding chapters build the mission's logic, the characteristics and science chapters describe the machine and the physics, the observation and exploration chapters replay the flight and the collision, and the discovery, challenge, and future chapters harvest the results and point to the follow-on work. The reader who wants the mission in one line can take the one this introduction has been circling: a spacecraft was thrown at a moonlet, the moonlet moved, and the species' defense of its own planet stopped being a theory and started being a practice, all of it measured, all of it public, and all of it, at the moment it mattered, one second of silence.

Chapter 1: The Discovery of DART

The discovery story of DART begins with a count and a consequence: the asteroids are many, the impacts are certain, and the twentieth century's planetary science, finishing its census of the near-Earth objects, closed with the question of what the species would do about the ones that cross our orbit.

The census had found the big ones, the kilometer-class impactors whose strikes would be global, mostly cataloged and mostly ruled out for the coming century, and the census's unfinished business, the smaller rocks, the tens-of-meters class that can level a city, remained numerous and largely uncataloged, the class of the Chelyabinsk airburst of 2013, the warning shot the era actually heard. The policy question followed the science: if a hazardous object were found with decades of warning, could anything be done?, and the answer the studies converged on was the kinetic impactor, a spacecraft flown into the asteroid to nudge it, a simple idea with a hidden problem, the nudge's size was unknown, because it depends on the asteroid's mass, structure, and surface, the very properties a distant telescope cannot read. The deflection could not be trusted until it was tested, and the test needed a target.

The target had to be a binary, and the choice was the Didymos system, discovered in 1996, whose moonlet Dimorphos, found in 2003 by a radar campaign, orbits the parent every twelve hours in an eclipse-timing system readable from Earth: a deflection of the moonlet's orbit could be measured by backyard telescopes, and the system, an Apollo-type asteroid that crosses Earth's orbit but never touches it, was a safe laboratory, a target where moving a rock could not endanger anyone. The mission, named the Double Asteroid Redirection Test, was approved in the planetary-defense line, built at the Applied Physics Laboratory, and launched on 24 November 2021 atop a Falcon 9 from Vandenberg, a spacecraft of about six hundred kilograms carrying a camera and an Italian cubesat, aimed at a moonlet the size of a stadium, seven million kilometers away.

The discovery of DART, in the sense meant here, is the discovery that the deflection question was answerable: the mission arrived, navigated, and struck, and the orbit changed by thirty-two minutes, far beyond the success threshold, and the answer to the century's policy question changed from maybe to demonstrated in a single afternoon. The chapters that follow are the account of how the demonstration was built, flown, and measured, and what it taught.

The discovery chapter should credit the mission's people, because DART was a small program with a public face: the Applied Physics Laboratory's team, the

principal investigators and engineers who built a deflection test for the price of a mid-size mission, the Italian partners who sent the cubesat, and the worldwide observers who timed the eclipses. The team's character shows in the mission's tone, the briefings that treated the collision as a shared civic event, the demonstrations the public could watch, and the reader who followed the impact's live broadcast saw the character in person, engineers narrating their own spacecraft's last minutes with the calm of people who rehearsed everything, which they had.

The launch deserves its own paragraph as the program's proof of economy: a Falcon 9, the era's cheapest ride, carried the first planetary-defense mission aloft from Vandenberg in November 2021, and the mission's whole cost, spacecraft, launch, and operations, fit inside the budget class the trade calls a mid-size, the affordability that made the test possible at all, since the deflection demonstration had to be cheap enough to be expendable. The discovery chapter's account of the mission's origins ends with the economics, the cheapest answer to the biggest question, which is the Discovery-era logic the mission rode, and the program's founders say plainly that without the cheap rockets the test waits a decade longer.

The discovery chapter's close belongs to the target's own discovery story, which the mission inherited: Didymos was found in 1996 by a survey of the near-Earth asteroids, the moonlet in 2003 by a radar campaign that caught the binary's eclipse timing, and the target's discovery, the census doing its work, is the precondition of the mission's, the deflection test needing a target the telescopes had found first. The close is the chapter's full circle, the census and the test, the two halves of the planetary-defense program meeting at a moonlet, and the reader who wants the program's whole shape can take it here, the finding of the rock and the moving of it, two decades apart, by the same species, on purpose, the discovery story this mission was named to finish.

The mission's purpose deserves its plainest statement here too, the sentence to carry through the book: DART was a test, not a defense, the asteroid it moved, no threat to anyone, the impact, an experiment in the safest possible circumstances, the species, rehearsing a rescue before there is anyone to rescue. The reader who wants the one-line version can hold this one, the defense of the planet, practiced on a harmless target, the understanding, the mission's whole meaning, the rehearsal, the point, the actual defense, hopefully never needed.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.