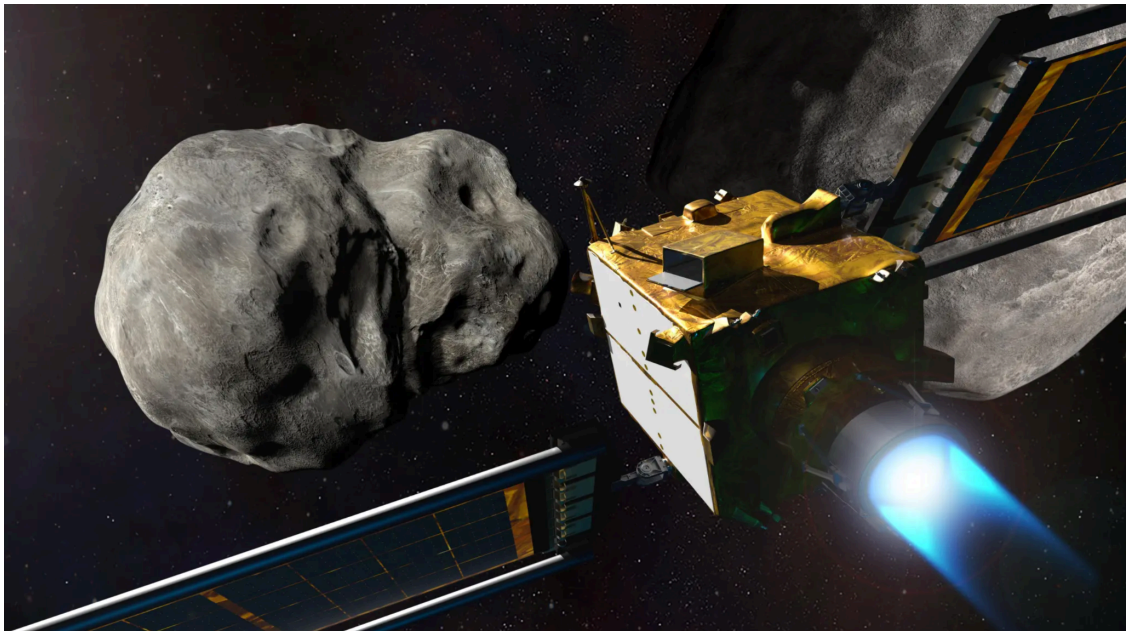

Artist's Depiction of the Double Asteroid Redirection Test (DART) (Credit: NASA)

Planetary Defense: How Humanity is Trying to Avoid The Fate of The Dinosaurs

By Deacon Carreon

Everyone has heard of the feeble tale of the dinosaurs' extinction caused by the Chicxulub meteor impact roughly 66 million years ago (now accelerated to pop culture thanks to the discovery of the event). But the threats of big asteroids never ended with the dinosaurs. Last December, the asteroid 2024 YR4 (58.42 meters in diameter) was discovered and hit headlines around the world. The European Space Agency (ESA) estimated the odds of it impacting Earth on December 22, 2032 to be 2.8%,[1] with NASA's estimate being as high as 3.1% on February 18, 2025.[2] Quickly since then, estimates fell back down to a measly 0.001% as of February 25, 2025.[1] However, had they continued to rise to a level high enough to prompt emergency attention, what action could have been taken?

We've seen a few close calls with asteroid impacts not only in prehistoric times but also in recorded history. One doesn't need to look very far to see it, as an ancient relic can be found in the Colorado Plateau in Arizona. Roughly 50,000 years ago, an iron-nickel asteroid 46 meters wide impacted the desert, creating the 1.2 kilometers wide Barringer Crater.[3] It has since eroded from being 210 meters to 150 meters deep.[3] This site is well known for being one of the oldest preserved instances where a meteor has actually hit the ground. Most meteors burn up or explode above the ground, such as those in recent history. Although not as catastrophic as the Barringer Crater, they have caught international attention because of how strikingly close they came to causing damage and harm.

On February 15, 2013 an asteroid with a potentially near-20 meter width exploded with 500 kilotons of TNT at an altitude of about 30 kilometers above the Russian city of Chelyabinsk, where many car dash cams were able to record the bright spectacle.[4] The resulting shockwave damaged 7200 buildings, and sent 1500 people to hospitals.[4] On June 30, 1908, a meteor exploded above Siberia, destroying roughly 80 million trees over a 2150 square kilometer area.[5] The meteor itself had little to no direct eyewitnesses, as only its aftereffects were noticed by the few natives and settlers.[5] Piecing together what we know, it could have been either a comet or a 36 meter wide asteroid.[5]

The biggest problems with these two events was that no one could predict their arrival,[4] which, considering that these meteors could have crashed or exploded over urban regions, could have led to far worse consequences. To address the threat of asteroid impacts, NASA's Center for Near Earth Studies (CNEOS) at Jet Propulsion Laboratory in Pasadena, California, has been documenting thousands of Near-Earth Objects (NEO).[6] An important distinction also being logged is the small fraction of NEOs which are considered Potentially Hazardous Asteroids;

these asteroids are at least 140 meters wide and have the potential to intercept Earth's orbit by 7.5 million kilometers in the future.[6] But recently, NASA took a more radical approach to planetary defense by launching one of the most daring scientific missions of the decade.

The Double Asteroid Redirection Test (DART) was launched on November 23, 2021; this test involved a spacecraft headed for the double asteroid system of Didymos (760 meters wide) and its orbiting asteroid, Dimorphos (150 meters wide).[7] The probe successfully smashed into Dimorphos on September 26, 2022, and shrunk its orbit around Didymos by 33 minutes (originally a roughly 11 hour and 55 minute orbit)[7]. This mission was carefully crafted, as Didymos and Dimorphos never were nor will ever be at risk of impacting Earth.[7]

The DART mission was a tremendous test of our ability to deflect the possible threat of an asteroid impact, if it arises in the near future. Another mission, the OSRIS-APEX mission, involves a spacecraft which, after collecting samples from asteroid Bennu in 2020, is on course for Apophis, a 340 meter wide asteroid[8] that will pass within 20,000 miles of Earth on April 13, 2029. The probe is planned to reach Apophis in June of that year, where it will study how its orbit, rotations, and physical characteristics have changed after its April 2029 flyby.[9] NASA is also planning to launch the NEO Surveyor in September 2027. The NEO Surveyor spacecraft aims to discover thousands of more asteroids that could impact Earth, with the goal of tracking 90% of total NEOs by 2035.[10]

These impressive missions have certainly contributed to our global effort for planetary defense; however, despite these exciting missions and successes, the threat of asteroid impacts still looms. While 2024 YR4 may not hit the Earth, it currently has a 4% chance of impacting the Moon. It could launch lunar material off of the lunar surface upon impact, hurling it into the

Earth's atmosphere on its 2032 approach.[11] Unfortunately, we cannot currently further our estimates as the asteroid has left our view until June 2028.[11]

Planetary threats like 2024 YR4 are crucial to our knowledge, not only because collective knowledge of natural recurring phenomena in the solar system is important, but also because these threats are incompatible with our way of life. It's important for everyone to be aware, because if we *do* manage to detect and deflect a high-threat asteroid's impact, we may be better off than the feeble dinosaurs.

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