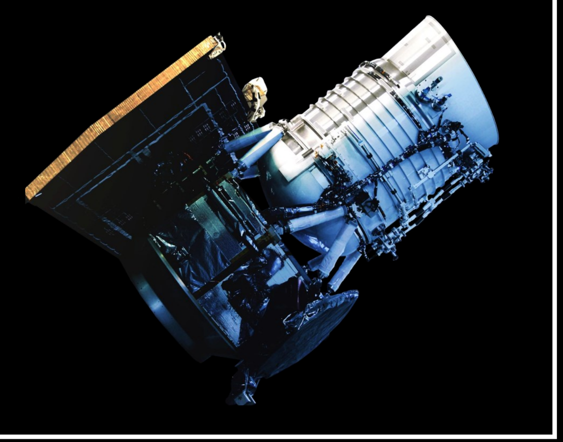
neo deflection techniques

Detection

NEOs can be detected by using satellite telescopes that operate in the infrared wavelength. This is because asteroids that are darker in colour will absorb more heat energy from the sun and appear brighter in the infrared images. Ground based telescopes that operate in the visible wavelength are more likely to miss asteroids that are darker in colour.
Even if asteroids are lighter in colour, they can still be seen using infrared telescopes. Once an asteroid has been detected, its orbital path can be calculated for years in advance to determine whether an asteroid will ever be a threat.[1][2]



Mass Driver

A mass driver is an electromagnetic tube that, when powered, will accelerate a magnetic bucket inside it and launch whatever is in the magnetic bucket. To deflect NEOs using this technique, a swarm of landers will drill into the NEO and launch the rocks using mass drivers at a certain point in the NEO's rotation. If the mined rocks are launched at this point for all mass drivers, the impulse created from firing them will move the NEO in the opposite direction, moving its path out of the way of the Earth.[11][12]

Gravity Tractor

A gravity tractor uses the very small gravitational force of a spacecraft in orbit around an NEO to change its acceleration over a time of up to decades. The tractor orbits one side of the NEO and uses thrusters to keep a constant distance from it. It can first land on the NEO and collect up to 50 tons of rock to increase its own mass which increases how well this technique performs.[13][14]

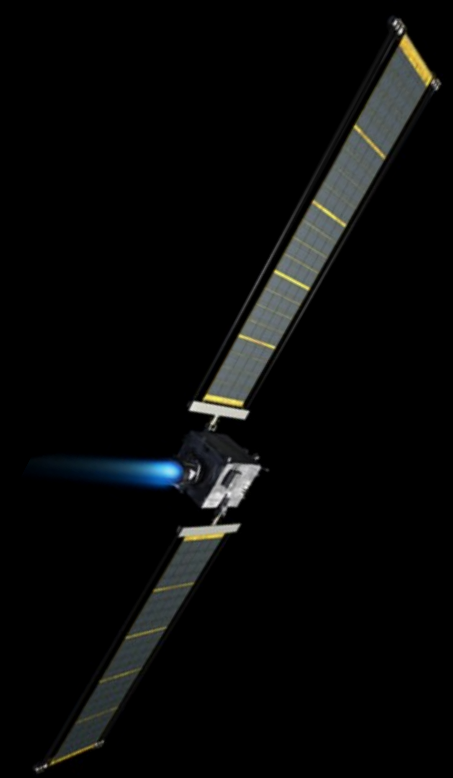
Image of Earth horizon from https://www.goodfon.com/
Image of asteroid from https://www.pinclipart.com/maxpin/xoRibb/wallpaper/space-stars-planeta-zemlya.html
Image of nuclear device from https://www.stickpng.com/img/miscellaneous/military/bombs/nuclear-missile
Image of NEOWISE from https://commons.wikimedia.org/wiki/File:Wide-field_Infrared_Survey_Explorer_spacecraft_model_2.png
Image of kinetic impactor from https://dart.jhuapl.edu/Mission/index.php

Intro/Background

In the instance of a potentially devastating impact event, there are little to no guidelines from any governing body that would give an optimal method of survival. Understanding Near-Earth Objects (NEOs) allows us to determine the likelihood of such an event and deduce the best course of action. Previous events are known to have caused mass extinctions through the destruction of biosystems and land masses, as well as airbursts that have caused disarray to respective societies. For these reasons, it is necessary to have a emergency plan of action. The following techniques have been proposed, researched and deemed the most feasible.

Kinetic Impactor

A kinetic impactor is a high speed spacecraft that is launched into the path of an approaching asteroid so that said asteroid is deflected away from the Earth's orbital path, at speeds of 10km/s or more. Kinetic impactors require a substantial warning time so that the asteroid can be deflected far enough away from the Earth's path. If all preparations were made so that kinetic impactors were available upon detection, a detection time of 1-2 years would be needed for smaller asteroids.[5][6][7] DART is a planetary defence-driven test for preventing an impact of Earth by an asteroid that is considered a major hazard to the Earth. DART will be the first demonstration of the kinetic impactor technique to change the motion of an asteroid in space. The total cost for NASA to launch DART is approximately $69 million, which includes the launch service and all other mission related costs.[8]



Conclusion

The kinetic impactor deflection technique is the best method to use in the scenario where the warning time is long and the NEO is small (<200m). However, nuclear detonation would be the better option if a rapid response is needed, or if the NEO is larger. The techniques such as the gravity tractor, which would take up to several decades to be effectively deflect, and the mass driver, which would be very expensive to research and operate would be feasible but less effective. Other techniques have been theorised however, were concluded to either produce too minor effects on the path of the NEO, or are impossible due to current technology and based on minimal research.

Damages

If an NEO was to hit the Earth, and the point of impact was into a large body of water, then it is highly likely that a large tsunami would be formed. On reaching land the waves would likely cause extensive damage to whatever is there and depending on the terrain could travel several miles inland [3]. An impact on land would cause a similar problem, with the earth material affected being thrown into the air and forming a dust cloud. This dust cloud would create an impact winter by greatly reducing the rate of photosynthesis due to the ejecta blocking out parts of the Suns rays from the surface which would affect all life on Earth [4].

Nuclear Detonation

Nuclear detonations have the highest energy density of any method for deflection and has a very quick deployment time. The most effective utilization of these devices is to detonate partially submerged in the surface of the NEO. This requires knowledge of the NEO's composition in order to find a cavity or to drill one to insert the device. The high energy density of the device allows for deflection of the largest of NEO's with a reasonable warning times and smaller NEO's for very limited warning times. A surface detonation has a lower energy transmission, but with less interaction needed. Stand-off detonations are an effective method for loosely bound NEO's. Again, it doesn't deliver as high proportion of energy compared to a surface/sub-surface detonation. The detonation should take place at perihelion to maximise velocity change [9].
The ethics of using this method is a problem which must be considered, which includes the risk of detonation at launch, but there is no regulation preventing the use of this method in space [10].

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