

# **The Potential Impact of Asteroid Apophis in 2029: Risks and "Nut Scenario" Analysis**

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## **Abstract**

Asteroid 99942 Apophis, approximately 340 meters in diameter, will make a close approach to Earth on April 13, 2029. This paper explores the scientific significance of this event, the potential impacts of Apophis, and a hypothetical "nut scenario" where the asteroid is deliberately nudged to impact Earth using nuclear explosives. We review current knowledge, assess the risks of a natural impact, and analyze the feasibility and consequences of artificially altering Apophis's trajectory.

## **Introduction**

Asteroid Apophis was discovered in 2004 and quickly gained attention due to its potential for a close approach to Earth in 2029. Initial estimates suggested a significant risk of impact, but further observations have ruled out this possibility for the foreseeable future ([Astronomy Stack Exchange](#)) ([European Space Agency](#)) ([NASA Science](#)). However, its close passage provides a unique opportunity for scientific observation and public engagement.

## **The Close Approach of Apophis**

On April 13, 2029, Apophis will pass within approximately 32,000 kilometers (20,000 miles) of Earth, closer than many geostationary satellites ([The Planetary Society](#)) ([European Space Agency](#)). This event will be visible to the naked eye in parts of Europe, Africa, and Asia, appearing as a moving point of light in the night

sky ([Astronomy Stack Exchange](#)) ([European Space Agency](#)). For observers in Kansas, the asteroid will be visible as it crosses over the United States ([Echo JPL](#)) ([NASA Science](#)).

## Potential Impact Scenarios

### Natural Impact

An unaltered impact of Apophis would be catastrophic, with the following potential consequences:

1. **Crater Formation:** A direct impact would create a crater several kilometers in diameter, releasing energy equivalent to hundreds of megatons of TNT ([Astronomy Stack Exchange](#)) ([The Planetary Society](#)).
2. **Blast Wave:** The resulting blast wave would devastate the surrounding area, flattening structures and causing extensive damage ([The Planetary Society](#)).
3. **Environmental Effects:** Dust and debris ejected into the atmosphere could block sunlight, leading to a phenomenon known as "impact winter," which could disrupt global climate and agriculture ([Astronomy Stack Exchange](#)) ([The Planetary Society](#)).
4. **Tsunamis:** An ocean impact would generate massive tsunamis, threatening coastal regions with waves that could inundate coastal cities and cause widespread destruction ([The Planetary Society](#)).

### Artificial Impact: The "Nut Scenario"

In a hypothetical "nut scenario," Apophis is deliberately nudged to impact Earth using nuclear explosives. This scenario explores the technical feasibility and potential consequences of such an action.

### Technical Feasibility

1. **Energy Requirements:** A 20-megaton hydrogen bomb would release approximately  $8.4 \times 10^{16}$  joules of energy. Assuming a 1% energy transfer efficiency, this could impart a velocity change ( $\Delta v$ ) of about 250 meters/second to Apophis ([NASA Science](#)) ([Space.com](#)).

2. **Multiple Explosions:** Achieving the desired trajectory change might require multiple precisely timed and positioned nuclear detonations to gradually alter Apophis's orbit ([NASA Science](#)).
3. **Orbital Mechanics:** Precise calculations and simulations would be necessary to ensure the asteroid follows the intended path towards Earth, accounting for gravitational influences and other celestial mechanics ([CNEOS](#)).

### Consequences of Artificial Impact

1. **Immediate Destruction:** The artificial impact would create a massive explosion, devastating the impact area and potentially causing millions of casualties depending on the impact location.
2. **Global Environmental Impact:** Similar to a natural impact, the explosion would release dust and debris into the atmosphere, potentially leading to global climate changes and agricultural disruptions.
3. **Legal and Ethical Issues:** Deliberately causing an asteroid impact would violate international treaties and raise significant ethical concerns. The use of nuclear weapons in space is restricted by treaties such as the Outer Space Treaty of 1967 ([NASA Science](#)) ([Space.com](#)) ([CNEOS](#)).

### Discussion

While the natural close approach of Apophis provides valuable scientific opportunities, the "nut scenario" of deliberately causing an impact highlights the significant risks and challenges involved. The precision required for such an operation is beyond current technological capabilities, and the potential consequences would be catastrophic.

### Monitoring and Preparedness

Continuous monitoring and tracking of near-Earth objects (NEOs) like Apophis are essential for planetary defense. Current strategies focus on preventing impacts through non-nuclear means, such as the kinetic impactor technique, which involves sending a spacecraft to collide with the asteroid at high speed to alter its trajectory ([NASA Science](#)) ([Space.com](#)).

## Conclusion

Asteroid Apophis's close approach in 2029 offers a unique opportunity for scientific observation and public engagement. While the potential impact of Apophis would be catastrophic, the hypothetical "nut scenario" of using nuclear explosives to nudge the asteroid towards Earth highlights the significant technical, legal, and ethical challenges involved. Preventative measures and continuous monitoring remain the most effective strategies for planetary defense.

## References

1. ESA. "Apophis." ESA. [Link](#).
2. NASA Science. "Scientists Planning Now for Asteroid Flyby a Decade Away." NASA Science. [Link](#).
3. Space.com. "Asteroid Apophis will visit Earth in 2029. Scientists want to send a probe first." [Link](#).
4. JPL. "99942 Apophis (2004 MN4)." NASA JPL. [Link](#).
5. The Planetary Society. "OSIRIS-APEX, NASA's asteroid Apophis chaser." [Link](#).

