



## Nuclear Rocket for Space Travel

**For Prelims:** [NASA](#), Demonstration Rocket for Agile Cislunar Operations, Project Orion, [Atomic bomb](#), [Perseverance Rover - NASA](#), [India's Mars Orbiter Mission](#), [UAE's Hope Mars Mission](#)

**For Mains:** Significance of DRACO, Nuclear Propulsion System

**Source:** IE

### Why in News?

[NASA](#) in collaboration with the **United States Defense Advanced Research Projects Agency (DARPA)** is seeking a nuclear propulsion system that could potentially **cut down the travel time to Mars by half**.

- This ambitious initiative, known as the **Demonstration Rocket for Agile Cislunar Operations (DRACO)** and the launch is scheduled for **late 2025 or early 2026**.

### What is DRACO?

- **About:** The DRACO project is offering the prospect of shorter travel times between celestial bodies and improved fuel efficiency. Central to DRACO's vision is a [nuclear reactor](#) that utilizes the **energy derived from the fission of uranium atoms**.
- **Significance:** DRACO hold the potential to revolutionize space travel in numerous ways:
  - **Acceleration and Speed:** Unlike traditional rocket engines that rely on chemical reactions (fuel like hydrogen or methane with oxygen), **nuclear reactions generate far more energy**, enabling the spacecraft to accelerate continuously throughout its journey.
    - This acceleration could significantly **shorten travel times to distant destinations like Mars**.
  - **Enhanced Fuel Efficiency:** Nuclear propulsion systems **yield greater fuel efficiency**, reducing the need to carry excessive propellant.
    - This advantage can drastically lower the duration of interplanetary voyages.
  - **Minimized Exposure:** Expedited travel times translate to **reduced exposure of astronauts to the harsh conditions** of deep space.
    - The potential risks associated with extended space travel, such as **radiation exposure and isolation**, could be mitigated through quicker journeys.
  - **Military Applications:** Beyond its application in space exploration, DARPA's involvement hints at the potential for nuclear propulsion to facilitate rapid [maneuvers of military satellites in Earth's orbit](#).
- **Concern:**
  - **Safety Concerns:** One of the primary concerns with using nuclear fuel in space is the potential for **accidents or malfunctions that could release radioactive material into space or back to Earth**.
    - Such incidents could have severe environmental and health consequences.
  - **Launch Risks:** Launching spacecraft with nuclear fuel on board presents risks, as there

is always a chance of a launch failure or explosion, leading to the **dispersion of radioactive material over a wide area.**

## What is the Historical Context of Nuclear Propulsion and How DRACO is Different?

- Projects like **Orion, Rover, and NERVA** explored nuclear-powered propulsion systems, although these initiatives were not fully realized.
  - Notably, **Project Orion considered using [atomic bomb explosions](#)** for acceleration, while **Project NERVA aimed to develop nuclear-thermal engines** akin to the DRACO engine.
- DRACO marks a significant evolution from its predecessors due to several key differentiators:
  - **Fuel Enrichment:** Unlike Project NERVA, which used **weapons-grade uranium**, DRACO employs a **less-enriched form of uranium**.
    - This shift enhances safety and minimizes the risks associated with the use of radioactive materials.
  - **In-Space Activation:** The nuclear reactor within the DRACO engine remains **dormant until it reaches space**.
    - This precautionary measure mitigates the potential for radioactive accidents during launch or on Earth.

### Note:

- **Atomic Bomb Explosions:** Atomic bomb explosions involve the **rapid and uncontrolled release of [nuclear energy](#)** through a chain reaction of nuclear fission.
  - The core of the bomb contains fissile material, like **uranium-235 or plutonium-239**.
- **Nuclear-Thermal Engines:** Nuclear-thermal engines are propulsion systems that use a nuclear reactor to heat a propellant, usually hydrogen, to high temperatures.
  - The heated propellant is then expelled through a nozzle at high velocity, creating thrust according to **Newton's third law of motion**.

## Mars

- **About:** Mars is the fourth planet from the Sun in our solar system. It is often referred to as the **"Red Planet"** due to its reddish appearance caused by **iron oxide (rust) on its surface**.
- **Atmosphere:** Mars has a thin atmosphere primarily composed of **carbon dioxide (95.3%), with traces of nitrogen and argon**.
- **Major Surface Features:**
  - **Olympus Mons:** The largest known volcano in the solar system.
  - **Valles Marineris:** A massive canyon system.
  - **Polar Ice Caps:** Ice caps made of water and frozen carbon dioxide (dry ice) at the poles.
  - **Dusty Surface:** The surface is covered in fine dust and rocks.
  - **Liquid Water:** Liquid water is rare, but evidence suggests past liquid flows.

## What are the Major Mars Missions?

- **[Perseverance Rover - NASA](#)**
- **[India's Mars Orbiter Mission \(MOM\)](#) or Mangalyaan (2013)**
- **ExoMars rover (2021) (European Space Agency)**
- **Tianwen-1: China's Mars Mission (2021)**
- **[UAE's Hope Mars Mission](#) (UAE's first-ever interplanetary mission) (2021)**
- **Mars 2 and Mars 3 (1971) (Soviet Union)**

## UPSC Civil Services Examination, Previous Year Question:

**Q. Consider the following statements: (2016)**

**The Mangalyaan launched by ISRO**

1. is also called the Mars Orbiter Mission
2. made India the second country to have a spacecraft orbit the Mars after USA
3. made India the only country to be successful in making its spacecraft orbit the Mars in its very first attempt

**Which of the statements given above is/are correct?**

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

**Ans: (c)**

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