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WEEKLY April 17–23, 2021

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WEIRD MUON RESULT SUGGESTS NEW FORCES

COVID-19 SURGES IN INDIA

REOPENING OFFICES SAFELY

HOW THE UNIVERSE REALLY WORKS

A radical new way to think about the laws of physics

By Chiara Marletto

LONG-LOST SHORES

Uncovering the secrets of our prehistoric coastlines

PLUS NUCLEAR SPACE ROCKET / **SPIDERWEB SYMPHONY** / **DITCHING FOSSIL FUELS** / ARTIFICIAL NERVOUS SYSTEM

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Space

Nuclear-powered rockets

The US plans to revive an old technology to make spacecraft that can be steered more easily

David Hambling

THE US is taking steps to put a nuclear thermal rocket in orbit by 2025, paving the way for improved navigation in space.

The Defense Advanced Research Projects Agency (DARPA) plans to turn the long-studied concept of a nuclear thermal rocket into a reality. The technology isn't powerful enough to launch a rocket from Earth, but could provide propulsion for an extended period once in space. This would make it ideal for manoeuvring in orbit or in deep-space missions.

"In the air, on the ground and at sea, manoeuvrability is a critical capability," says DARPA project manager Nathan Greiner. "Nuclear thermal propulsion will give us that agility in space."

Such rockets use nuclear power to heat cold propellants to high temperatures, which causes the propellant to expand and provide thrust. The idea for nuclear thermal propulsion was developed by the US Air Force in 1946, as well as by Qian Xuesen at the Massachusetts Institute of Technology in 1947.

The engine will run for as long as the supply of propellant – typically hydrogen – lasts, which would probably be a few weeks.

The project is being facilitated in part by a 2019 US presidential memorandum, which made it simpler to get approval for launches containing radioactive material. To fit in with the rules set out by the memorandum, the project will have a less radioactive power source than previous ones, such as NASA's Nuclear Engine for Rocket Vehicle Application programme in the 1960s, which developed nuclear thermal rockets without testing them in space.

Contracts to design both a demonstration system and a full-blown spacecraft have now been awarded to General Atomics, Blue Origin and Lockheed Martin.

The project will focus on satellites in orbits of up to 400,000 kilometres above Earth, which is far higher than current space operations carried out by military spacecraft. With the technology, military operators could move nuclear-powered communications or spy satellites at will to an area of interest. It could also open up new possibilities, such as tracking and identifying rival stealth satellites.

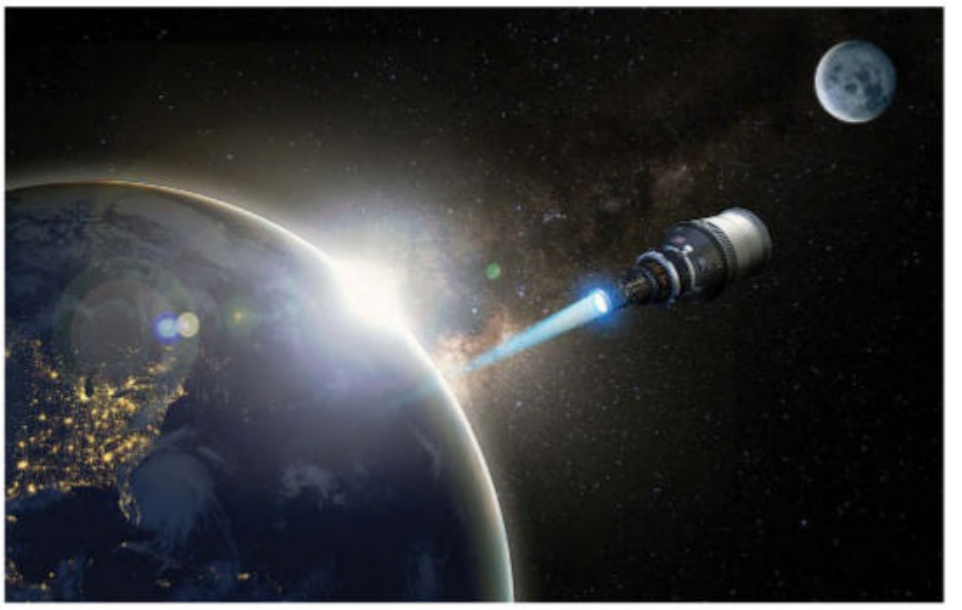
Nuclear thermal rockets could have improved manoeuvrability in space

Launching nuclear rockets comes with its own challenges. In 1983, a nuclear reactor on the Soviet Kosmos 1402 spy satellite caused major concern when it malfunctioned and spiralled towards Earth. Fortunately, it burned up harmlessly in the atmosphere as it had been designed to do.

To reduce the risks involved, the DARPA reactor won't be activated until it is in space. "If the reactor hasn't been operated, then it's basically just a quantity of low-enriched uranium," says Laurence Williams, a specialist in nuclear safety at Imperial College London.

He says that a detailed safety analysis would still be needed before any launch, looking at what might happen if the rocket failed at lift off or blew up in the atmosphere afterwards.

If the DARPA project succeeds, we could soon see a whole generation of nuclear spacecraft in Earth orbit and beyond. NASA has long been interested in nuclear thermal propulsion for missions to Mars and elsewhere. ▮



DARPA

Technology

Regular headphones can detect a heart rate and count steps

THE tiny speakers inside standard headphones convert electrical signals into sound waves that we can hear. But the process can also work in reverse.

Vibrations near the speakers – such as those from a heartbeat or from speaking – create electrical signals. Xiaoran Fan at the Samsung Artificial Intelligence Center in New York and his colleagues leveraged this effect to measure a wearer's heart rate and count their steps. By playing a short sound, the headphones can be used to identify someone using reflections from their uniquely shaped ear canals.

The signals are extremely weak compared with audio signals from a smartphone or computer and could be easily lost. So the team created a small electrical circuit to filter out the incoming signals and allow the fluctuations to be recorded while still letting the wearer listen to music.

The system achieved more than 96 per cent accuracy when identifying the wearer among a group of 27 participants. The heart rate of the wearer was detected with more than 96 per cent accuracy when compared with a pulse oximeter. The researchers were also able to detect two different gestures, a tap and a stroke, on the outside of the headphones with more than 98 per cent accuracy (*Proceedings of MobiCom '21*, doi.org/f5mc).

"The heart rate of a wearer was detected with 96 per cent accuracy compared with a pulse oximeter"

This circuit can be built with nothing more than two resistors. It uses no power and could be built into a smartphone or an adapter for use with existing phones at a cost of just 50 pence. Fan says simple signal processing on a computer then extracts the information, but that any standard smartphone could do this. ▮

Matthew Sparkes