Science & Technology Briefs

For Low-Energy Nuclear Reactions Studies, New U.S. ARPA-E Funding

The U.S. Department of Energy, through its Advanced Research Projects Agency–Energy (ARPA-E), announced Sept. 13 that it will spend up to $10 million for work to establish clear research practices to determine whether low-energy nuclear reactions (LENR) can be a practical source of energy. ARPA-E says, concerning its LENR funding more generally, that it makes grants to scientists "to pursue hypotheses-driven approaches … by testing/confirming specific hypotheses (rather than focusing only on replication), identifying and verifying control of experimental variables and triggers, supporting more comprehensive diagnostics and analysis, and improving access to broader expertise and capabilities on research teams."

LENR occur under certain conditions in metal hydrides or deuterides (metals with hydrogen or heavy hydrogen dissolved in them), when an external stimulus such as an electric current is applied, which is why many researchers believe the effect is a form of nuclear fusion. LENR also produces charged particles and occasionally a very low level of neutrons. In some experiments the host metal has been transmuted into other elements. LENR has been seen in palladium, titanium, nickel, and some superconducting ceramics.

Over 30 years, the heat from LENR in many experiments has far exceeded the amount that can be produced by any chemical fuel. LENR produce no nuclear waste and no dangerous radiation.

Recent developments in LENR research have led to a high increase in sustained power gain since the original experiments in 1989 that used palladium and deuterium electrolysis. Promising results have been obtained in recent years with nickel, and many researchers are now focused on this element. Nanoparticle palladium also seems especially promising.

Some scientists contend that the occurrence and properties of LENR are already well documented, even though the mechanisms that cause LENR are not yet understood. LENR is not yet a source of usable energy.

Steven B. Krivit's "Review of Low-Energy Nuclear Reactions" provides details of research up to 2013.

Russia's Mammoth New Submarine and Poseidon Torpedo

The launch of the submarine *Belgorod* on July 8, 2022 should have been part of Western discussions about Russia's military capabilities, alongside hypersonic missiles.

The mammoth, nuclear-powered *Belgorod* (BS-329), at 15 meters wide and 184 meters long—the longest in existence—is the first of a class of submarines designed to carry the Poseidon nuclear-powered and nuclear-armed drone torpedo, which is capable of traveling far under water for hundreds of miles. Exploded near a coastline, such a torpedo would cause a "nuclear tsunami."

Russia has been and is developing weaponry qualitatively more advanced than what Western defenses are designed to protect against. Russia made a clear strategic decision years ago about Western intentions and decided that Russia had to outflank the West.

A TASS wire quotes Russian Navy Commander-in-Chief Nikolay Yevmenov concerning other capabilities of the *Belgorod*, saying that it "opens new opportunities for Russia in holding various researches and helps carry out diverse scientific expeditions and rescue operations in remote areas of the World Ocean."

Russia Provides Giant Poloidal Magnet for ITER Tokamak

On November 1, Russia dispatched by ship one of the six giant poloidal field coil magnets needed for ITER (the International Thermonuclear Experimental Reactor) in France, an international fusion energy project that has refused to exclude Russian participation under the pretext of the Ukraine war.

Built in St. Petersburg under Rosatom's supervision, the massive, 9-meter diameter ring-shaped magnet, weighing 200 metric tonnes, will be placed at the top of the reactor. The poloidal field coils, positioned around the vacuum vessel and D-shaped toroidal field coils, help shape the plasma and keep it away from the vessel's walls.

The magnet was set to leave in May, but sanctions forbidding Russian ships from docking in Europe delayed the departure. Said Viacheslav Perchukov, Rosatom representative for international projects:

"The current situation did not change the fact that we will fulfill our obligations. [Geopolitical tensions] practically did not affect the realization of this project."

Senior ITER scientist Leonid Khimchenko told AFP:

"Without [the Russian coil], the tokamak will not work. ITER is such an interesting project, that in fact we are all one family…. There is no competition between us, nothing. It's separate from the war in Ukraine."

Tim Luce, Director of Science at ITER, told CBS News:

"The need for energy is universal, and if one entity has it and another doesn't, it doesn't matter who—which flags or which hats—we put on the people. The inequity will always cause conflict."

Andrey Mednikov, a scientist in charge of the production of the poloidal field coil, praised the continuing international cooperation: "If this cooperation was brought to a halt, everyone would lose: both Russia and the international community."

China's New Telescopes For Studying the Sun

As reported in *China Daily* and other media, on Oct. 9 China launched the Advanced Space-Based Solar Observatory (ASO-S), its first comprehensive space-based solar telescope. It is nicknamed Kuafu-1, after a giant in Chinese mythology who tried to chase the Sun.

This mission will allow scientists to study images of the Sun during its most active phase—solar maximum. Sunspot activity rises and falls in an approximate 11-year cycle; we're now in cycle 25, which began in 2019 and should reach solar maximum between 2024 and 2026. As sunspot activity increases, the number and intensity of solar flares and coronal mass ejections (CME) increase, which can affect weather on Earth, as well as communications and GPS satellites.

According to *China Daily*, "The 859 kg ASO-S observatory, operating at 720 km above Earth, is China's first full-scale instrument dedicated to studying the Sun. It is equipped with 3 special pieces of equipment to aid the effort and is set to operate for more than 4 years: a full-disk vector magnetograph, a hard X-ray imager, and the Lyman-alpha Solar Telescope, all of which will be put into use for the first time."

"Access to data collected by the instruments will be free for scientists around the world working in fields including solar physics, space environment and space weather."

NASA and the European Space Agency already have space-based missions studying the Sun at various wavelengths and distances. India's planned Aditya-L1 will be that nation's first mission for solar observations.

China also has an ambitious, land-based project to study the Sun, the Daocheng Solar Radio Telescope (DSRT). Just completed on the Tibetan Plateau in Sichuan province, it consists of 313 dishes, each 6 m across, that form a circle with a circumference of 3.14 km. It is the world's largest circular radio telescope array.

DSRT will primarily be used to study coronal mass ejections (CME)—bursts of magnetized plasma from the Sun that travel at speeds ranging from slower than 250 km/s to nearly 3,000 km/s. When its path is toward Earth, a CME can wreak havoc on power grids, telecommunications, orbiting satellites (such as GPS) and even put the safety of in-space astronauts at risk. CMEs also create the breathtaking aurora displays at the auroral ovals around Earth's poles.

DSRT is part of the larger Meridian Space Weather Monitoring Project, which includes the Chinese Spectral Radioheliograph for monitoring solar activity, being constructed in Inner Mongolia. The radioheliograph will consist of 100 dishes in a three-arm spiral arrangement and will study the Sun in a wider band of frequencies than DSRT, to study the Sun, solar physics, and space weather.

The project also includes some innovative technologies, such as a 3-station incoherent scattering radar to make 3D measurements of the ionosphere and a helium lidar to measure atmospheric density up to an altitude of 1,000 km.

The entire project aims to run close to 300 instruments deployed at 31 stations across China. It is led by the National Space Science Center of the Chinese Academy of Sciences and involves more than 10 institutions and universities in China.

Artemis Moon-Mars Mission Gets Underway

Although more than a year behind its original schedule set under the Trump Administration, the Artemis Moon-Mars mission got underway Nov. 16, when the giant Space Launch System (SLS) rocket lifted off from Pad 39B at the Kennedy Space Center in Florida in a round-trip voyage to the Moon. With its 4 R-25 engines producing a total thrust of 8.8 million pounds, the SLS is 15% more powerful than the Saturn V. Sitting atop the SLS was the Orion Space Capsule (uncrewed this time), and the Service Module (housing the propulsion, power, and life support equipment for Orion). Ten CubeSats were also aboard, one of which will be the smallest spacecraft ever to make a lunar landing.

An international effort under NASA's direction, the SLS was built by Aerojet Rocketdyne, Northrop Grumman, Boeing, and United Launch Alliance; the Orion by Lockheed Martin, and the Service Module by the European Space Agency. The CubeSats were constructed by various entities.

This is Artemis 1 of the four planned Artemis flights of which the third intends to land astronauts for the first time since Apollo 17 in 1972, and the fourth flight is intended to make the initial, small start on creating an infrastructure for long-term human activity on the lunar surface.

Orion is scheduled to splash down in the Pacific Ocean Dec. 11.