Science & Technology Briefs

China Prepares for Fusion Power

An article in *Science and Technology Daily* Nov. 28 focuses on the new Comprehensive Research Facility for Fusion Technology (CRAFT) at Hefei University of Science and Technology, the home of the Experimental Advanced Superconducting Tokamak (EAST) reactor. Hefei's thermonuclear fusion science team at the Institute of Plasma Physics has conducted research on the performance of materials, superconducting magnets, fusion reactor vacuum chambers, divertor components, and the interaction between plasma and materials.

CRAFT is not a fusion reactor, but is designed to develop all the technologies for the next stage of fusion research—the Chinese Fusion Engineering Testing Reactor. It will be the penultimate stage before the development of the demonstration reactors succeeding ITER, to be built in several countries before the development of commercial reactors. The CRAFT facility consists of 14 buildings on a campus of 400,000 square meters and is scheduled to be completed in 2024.

Fusion Power in Six Years?

Prof. Peng Xianjue of the Chinese Academy of Engineering Physics announced Sept. 9 that the government had approved the construction of the world's largest pulsed-power plant, to be built in Chengdu, Sichuan province, and that China intends to produce controlled nuclear fusion energy by 2028. The announcement was reported Sept. 16 in *The EurAsian Times.*

The device is a fusion-fission hybrid that uses the Z-pinch configuration. Anticipated to be finished in 2025, it will be capable of generating electricity at 50 million amperes, about twice as much as the comparable record-breaking Z-pinch pulsed power facility at Sandia National Laboratory. Z-pinch machines can store huge amounts of electricity and release them in nanoseconds. The electric pulse can generate "enough pressure and radiation for two lightweight atoms to fuse into a heavier one and give up some mass in the form of energy."

Prof. Peng said his team would attempt to ignite a nuclear fusion reaction using a modest quantity of the hydrogen isotopes deuterium and tritium. The team intends to limit the pulse energy released to a few hundred million joules. In contrast to earlier designs, the facility's fusion energy will not be used to power the grid, but rather to create a swarm of fast particles that will strike uranium embedded in the fusion ignition chamber's walls, causing the uranium atoms to fission and release large amounts of energy. This combination of fusion and fission reactors gave rise to the design's designation, Z-FFR.

New DNA-Editing Therapy Effective in Leukemia Case

For the first time, DNA editing has been used—and used successfully—to cure leukemia, a cancer of the white blood cells.

BBC News carried a detailed story on Dec. 11, 2022. A British teenaged girl diagnosed with T-cell acute lymphoblastic leukemia did not respond to chemotherapy and bone marrow transplants. Using a new technology known as "base editing," however, her medical team at Great Ormond Street Hospital, London, engineered a new type of T-cell that killed her cancerous T-cells. T-cells are part of the immune system. The team actually redirected her immune system to kill the cancer.

BBC News explained, "Bases are the language of life. The four types of base—adenine (A), cytosine (C), guanine (G) and thymine (T)—are the building blocks of our genetic code. Just as letters in the alphabet spell out words that carry meaning, the billions of bases in our DNA spell out the instruction manual for our body. Base editing allows scientists to zoom to a precise part of the genetic code and then alter the molecular structure of just one base, converting it into another and changing the genetic instructions."

The girl had her T-cells replaced by edited T-cells from a donor. The donor cells were first modified to remove CD7, a unique marker characteristic of T-cells, made immune to a chemotherapy drug, and edited to hunt any cells displaying CD7. The new donor cells destroyed the girl's cancerous T-cells. A new bone-marrow transplant (white blood cells are generated in the bone marrow) will allow her to rebuild her new immune system.

The case made medical history. Meanwhile, some much less dramatic—but successful—clinical trials involving base editing are reported in a major review article in the *Nature* journal *Signal Transduction and Targeted Therapy* of Jan. 16, titled, "CRISPR/Cas9 Therapeutics: Progress and Prospects," by Tianxiang Li *et al.* The article identifies serious difficulties that remain to be solved.

Webb Telescope: Barred Spirals in Distant Past

New images released from the James Webb Space Telescope (JWST) show barred spiral galaxies existing

at a time when the universe was an estimated 11 billion years old, ostensibly about a quarter of its present age, according to a Jan. 5 report on phys.org.

Most spiral galaxies have bars. Instead of having several arms, they have just two, each extending from one end of the bar. The bars themselves are elongated regions of stars stretching from the galaxy center to their outer disks.

One would expect material from the center to be moving outward along the arms under centrifugal force. But the bars fly in the face of commonly accepted physics, funneling gas and dust in *toward the center*, boosting star formation. That these strongly star-forming galaxies were discovered in an epoch far younger than previously thought also challenges current theoretical models.

Describing data from the Cosmic Evolution Early Release Science Survey, Professor of Astronomy Shardha Jogee, University of Texas at Austin, said:

"JWST can unveil structures in distant galaxies better than Hubble for two reasons: First, its larger mirror gives it more light-gathering ability, allowing it to see farther and with higher resolution. Second, it can see through dust better as it observes at longer infrared wavelengths than Hubble."

Yuchen Guo, a graduate student who led the analysis:

"For this study, we are looking at a new regime where no one had used this kind of data or done this kind of quantitative analysis before, so everything is new. It's like going into a forest that nobody has ever gone into."

Partnership to Build First Spaceport on African Soil

Djibouti and the Hong Kong Aerospace Technology Group have just formalized a partnership to build a $1 billion spaceport in Djibouti in five years for launching satellites and rockets, according to the New Africa Channel on YouTube, Jan. 20. It quotes Victor Mwongera, head of the Mechanical Engineering Department at Kenyatta University, Kenya, who said it will be a launch base for all Africa.

From South Korean Lunar Orbiter, Stunning Pictures

Images of the Moon and the Earth captured by South Korea's Danuri spacecraft are stunning. The mission, also known as the Korean Pathfinder Lunar Orbiter, launched in August 2022, arrived in low lunar orbit in mid-December, as reported Jan. 2 by Andrew Jones for space.com. South Korea now joins the few nations that have executed successful Moon missions.

One important task is to collect data using a NASA instrument on board to examine permanently shadowed regions at the lunar poles. There have been indications of water ice at the poles.

The science mission, scheduled to last about a year, is currently undergoing commissioning. The Korean Aerospace Research Institute (KARI) involved students in a competition to name the spacecraft.

India's First Commercial Rocket Lofts 36 Satellites into Low Earth Orbit

The Indian Space Research Organization (ISRO) successfully completed its first on-demand commercial space delivery mission for a foreign customer on Oct. 23. On that date, India's heaviest rocket vehicle, LVM3-M2, was launched from the Satish Dhawan Space Center in Sriharikota, Andhra Pradesh (in southern India) and put 36 satellites of about 150 kg each of the UK-based Network Access Associates' (OneWeb) constellation into a low Earth orbit (LEO).

The LVM3-M2 is a 3-stage launch vehicle consisting of a core with a liquid stage and a cryogenic stage, and two solid propellant strap-on boosters on its sides.

OneWeb is a global communications network, and a customer of ISRO's commercial arm, NewSpace India, Ltd (NSIL). It will eventually have 648 LEO satellites deployed, capable of processing very high volumes of government, business, and personal data messages with minimal delay (latency). This type of network is designed to support operations that require processing of rapidly-changing data in near real-time.

ISRO Chairman Sreedhara Somanath answered questions at the Oct. 23 press conference directly after the launch. As reported Oct 27 in *The Hindu*, he said:

"Science [for ISRO] was never a priority but it must become the priority in the future. We've always had a very limited budget for science but we need more money so that we can do science missions.... NASA is the national space agency of the United States and decides that country's space activities. ISRO is the national space agency of India but the way both operate could be different because the U.S. ecosystem already has a developed industry. In India, there is no industry capable of doing anything (space launches, satellite manufacturing) independently. Thus, ISRO's role is to mentor and develop the industry ecosystem here."

Prime Minister Narendra Modi tweeted his congratulations to the ISRO team: "LVM3 exemplifies *Atmanirbharta* (Self-reliant India) & enhances India's competitive edge in the global commercial launch service market."