Historic Mars helicopter test flight set for early

LOS ANGELES: NASA engineers plan to send a miniature helicopter whirring just above the surface of Mars next month in an interplanetary aviation experiment that, if successful, would mark the first powered, controlled flight by an aircraft on another celestial body. The U.S. space agency is comparing the Martian debut of its 4-lb (1.8-kg) solar-powered whirlybird, dubbed Ingenuity, with the Wright Brothers' first sustained flight of a motor-driven airplane near Kitty Hawk, North Carolina, in 1903.

Paying homage to that feat, a tiny swath of wing fabric from the original Wright Brothers plane has been fastened underneath the helicopter's solar panel and will go aloft with Ingenuity when it takes flight roughly 150 million miles from Earth.

Engineers at NASA's Jet Propulsion Laboratory (JPL) near Los Angeles, where Ingenuity was designed and built, are aiming to launch the twin-rotor, four-legged helicopter on its maiden test flight sometime around April 8. The helicopter was carried to the red planet last month strapped to the belly of NASA's Mars rover Perseverance, which landed Feb. 18 on the floor of a vast basin called Jezero Crater after a nearly seven-month journey through space.

Perseverance, a robot lab on wheels, is designed primarily to seek out traces of fossilized microbial life from Mars' ancient past and to collect rock specimens for return to Earth through future missions to Mars.

One of its first tasks is to transport Ingenuity to its test-flight zone, a flat area near Perseverance's landing site. There the helicopter will be unloaded by remote control and set on the surface before the rover drives carefully away. NASA has set aside 30 Martian days to unpack and prepare the helicopter for its historic, but modest, first spin. It will take off on a slow, vertical ascent to about 10 feet (3 meters), hovering for 30 seconds, rotating in the air and then descending to a gentle touchdown.

JPL plans to film the entire exercise with cameras mounted on Perseverance, parked a short distance away, and will beam images back to Earth hours later. Ingenuity is also equipped with two cameras of its own used for navigation. The helicopter will undertake additional flights up to 16 feet (5 meters) high, assuming the initial foray unfolds as expected.

WRIGHT BROTHERS MOMENT: If successful, NASA hopes Ingenuity - a technology demonstration separate from Perseverance's astrobiology mission - paves the way for aerial surveillance of Mars and other destinations in the solar system, such as Venus or Saturn's moon Titan. The immediate goal, however, is achieving "that Wright Brothers moment, getting powered, controlled flight, then adding mobility and adding other capabilities like any flight-test program," said Bobby Braun, JPL's planetary science director. While Mars possesses just a third of the gravity to overcome as Earth, its atmosphere is just 1% as dense, presenting a special challenge for aerodynamic lift. To compensate, engineers equipped Ingenuity with rotor blades that are larger (4-feet-long) and spin more rapidly than would ordinarily be needed for an aircraft of its size. The design was successfully tested in vacuum chambers simulating Martian conditions at JPL, but it remains to be seen whether Ingenuity will fly on the red planet. The small, lightweight aircraft must also withstand punishing cold, with nighttime temperatures dropping as low as 130 degrees below zero Fahrenheit (minus 90 degrees Celsius), using solar power alone to recharge its batteries and keep internal components sufficiently heated. **—Reuters**

Harvesting energy from radio waves to power wearable devices

Along with being signals, radio waves are also sources of energy themselves. Scientists from the Penn State Department of Engineering Science and Mechanics have found a way to harness that energy.

They have come up with a new way to use energy from radio waves to power wearable devices. Huanyu "Larry" Cheng, Dorothy Quiggle, Career Development Professor in the Penn State Department of Engineering Science and Mechanics, said, "We don't want to replace any of these current power sources. We are trying to provide additional, consistent energy."

Scientists developed a stretchable wideband dipole antenna system that can wirelessly transmit data collected from health-monitoring sensors.

The system consists of two stretchable metal antennas integrated onto conductive graphene material with a metal coating. The system's wideband design allows it to retain its frequency functions even when stretched, bent and twisted. This system is then connected to a stretchable rectifying circuit, creating a rectified antenna, or "rectenna," capable of converting energy from electromagnetic waves into electricity. This electricity can power wireless devices or charge energy storage devices, such as batteries and supercapacitors.

This rectenna can convert radio, or electromagnetic, waves from the ambient environment into energy to power the sensing modules on the device, which track temperature, hydration, and pulse oxygen level. Compared to other sources, less energy is produced, but the system can generate power continuously — a significant advantage. Cheng said, "We are utilizing the energy that already surrounds us — radio waves are everywhere, all the time. If we don't use this energy found in the ambient environment, it is wasted. We can harvest this energy and rectify it into power."

"This technology is a building block for him and his team. Combining it with their novel wireless transmissible data device will provide a critical component that will work with the team's existing sensor modules." "Our next steps will be exploring miniaturized versions of these circuits and working on developing the stretchability of the rectifier. This is a platform where we can easily combine and apply this technology with other modules that we have created in the past. It is easily extended or adapted for other applications, and we plan to explore those opportunities." **—Reuters**

Filters from tree branches to purify drinking water

Trees like pine and ginkgo have sapwood lined with straw-like channels called xylem. The function of this xylem to draw water up through a tree's trunk and branches. There are thin membranes that interconnect all the xylem channels together. The membranes that act as natural sieves refines bubbles from water and sap. While understanding sapwood's natural filtering ability, MIT engineers have previously developed simple filters from peeled cross-sections of sapwood branches. They also demonstrated a low-tech design that filters out the bacteria.

Now the same team has advanced technology- new xylem filters that can efficiently filter out the pathogens such as E. coli and rotavirus. Not only the pathogens, but the filter can also remove bacteria from contaminated springs, tap, and groundwater. Along with this advanced filter technology, scientists also developed some techniques that increase the filter's shelf life, hence enabling the woody disks to purify water after being stored in a dry form for at least two years.

Scientists took their techniques to India, where they made xylem filters from native trees and tested the filters with local users. Based on their feedback, the team developed a prototype of a simple filtration system fitted with replaceable xylem filters that purified water at a rate of one liter per hour. Rohit Karnik, professor of mechanical engineering and associate department head for education at MIT, said, "Because the raw materials are widely available and the fabrication processes are simple, one could imagine involving communities in procuring, fabricating, and distributing xylem filters. For places where the only option has been to drink unfiltered water, we expect xylem filters would improve health and make water drinkable." In past studies, engineers found some limitations to wooden material's natural filtering ability. **—Agencies**

Remnants of the impact that formed the Moon may be buried deep within the Earth

According to the giant-impact hypothesis or Theia Impact, the Moon Moon formed from the ejecta of a collision between the Earth and a protoplanet called Theia about 4.5 billion years ago.

A team of scientists recently suggests that the Earth's core may bury the Theia's fragments. Theories related to what happened to the rest of Theia are still being argued. In this new study, scientists suggest that much of Theia's mantle wound up in Earth's mantle, forming what is now called the large low-shear-velocity provinces, LLSVPs—one beneath parts of the African continent and one beneath the Pacific Ocean. These two blobs are up to 1000 kilometers tall and several times that wide. Seismic waves from earthquakes abruptly slow down when they pass through the layers. It means the blobs are relatively denser and chemically different from the surrounding mantle rock.

Theia's mantle was denser than Earth's. Any of its fragments that made its way to the mantle gradually reached Earth's core. Scientists built a model to determine what could have happened if there were a collision with a planet the size of Mars or even larger. The model depicts Earth as it was 4.5 billion years ago. It suggests that after the collision, Theia's core would have quickly merged with Earth's. Over billions of years, the fragments merge, forming the LLSVPs. Jennifer Jenkins, a seismologist at Durham University, said, "If Theia's remnants do lie deep in Earth's mantle, they may not be alone. Seismologists increasingly see small, ultradense pockets of material in the deep mantle, only a few hundred kilometers across, often near the RSVPs' edges. Maybe they are the sunken remnants of iron-rich cores from other miniature planets that hit early Earth." **—Agencies**

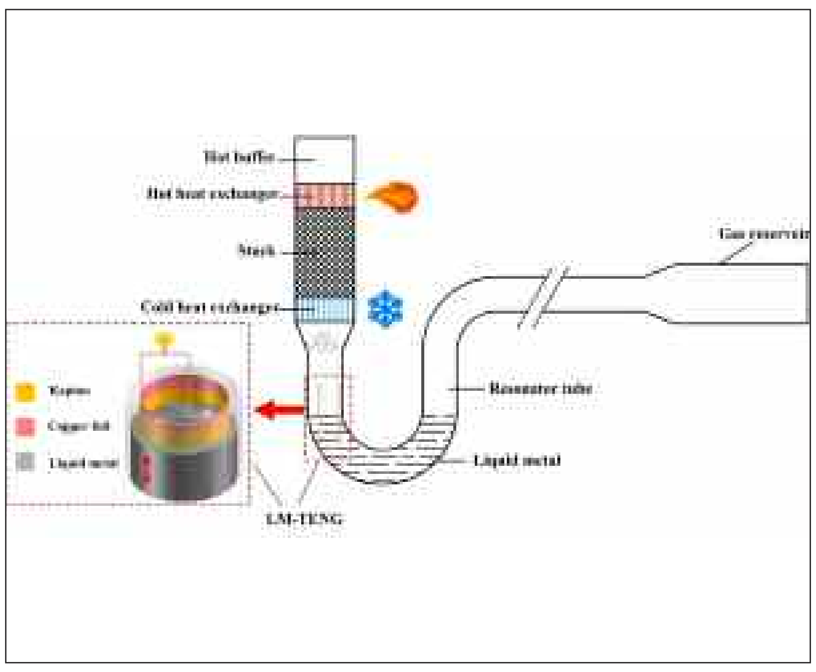
A highly reliable thermal power generator

Liquid metal has exhibited great potential in escalating power density in both triboelectric nanogenerator and thermoacoustic systems. By coupling these two systems, Chinese scientists have proposed a highly reliable thermal power generator that could convert thermal energy into electric energy.

The exciting thing is the generator does not consist of any substantial moving parts. Besides, it is highly reliable and readily achieves a long life span. It also offers a theoretically high heat-to-electric conversion efficiency.

Scientists dubbed this new power generator as a thermo-acoustically driven liquid-metal-based triboelectric nanogenerator (TA-LM-TENG). It consists of two parts: thermoacoustic engine (TAHE) and liquid-metal-based triboelectric nanogenerator (LM-TENG).

The TAHE first converts thermal power into acoustic energy using thermal expansion and compression of the working gas. The LM-TENG then converts the acoustic energy into electrical energy through the coupling impact of contact electrification and electrostatic induction. As shown in schematics, when heating the hot heat exchanger of the TAHE, the working gas in the engine will start spontaneous oscillation. The active gas's oscillatory motion pushes the liquid metal column resonantly flowing upward and downward in the U-shaped tube. Liquid metal is immersed and separated with the Kapton material periodically. The generator, therefore, generates an alternate electric potential difference at the electrodes. Electrical power is extracted from the TA-LM-TENG. **—Reuters**



Scientists observed first milliseconds of crystal formation

Revealing the Nano Big Bang

The nucleation process occurs while forming a crystal from a solution, a liquid, or a vapor, in which an atomic cluster first takes place. Nucleation in atomic crystallization remains poorly understood, despite advances in classical nucleation theory.

According to classical nucleation theory, the process involves a spontaneous transition from disordered to crystalline states, but a detailed understanding of dynamics requires further investigation. The theory suggests that crystals form one atom at a time, steadily increasing the level of order.

Modern studies have also observed a two-step nucleation process, where a temporary, high-energy structure is first formed, which then transforms into a stable crystal.

A new study by the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) suggests that reality is far more complicated than thought.

According to the latest findings, instead of clustering one by one, the atoms self-organize themselves, fall apart, rearrange and reorganize several times before creating a crystal. Scientists observed this rapid process using an advanced electron microscope. The study offers a detailed view of the early stages of crystal formation.

Peter Marcus, one of the study's lead authors, said, "As scientists seek to control matter at smaller length scales to produce new materials and devices, this study helps us understand exactly how some crystals form."

Won Chul Lee, one of the professors guiding the project, describes it this way, explained, "In line with conventional understanding, once the crystals in the study reached a certain size, they no longer returned to the disordered, unstable state."

"Imagine each atom as a Lego brick, then instead of building a house one brick at a time, it turns out that the bricks repeatedly fit together and break apart again until they are finally strong enough to stay together. However, once the foundation is set, more bricks can be added without disrupting the overall structure."

Thanks to newly developed detectors on TEAM I, the team was able to see unstable structures. The TEAM I is one of the world's most powerful electron microscopes.

Using the microscope, scientists could capture real-time, atomic-resolution images at speeds up to 625 frames per second. Scientists also observed individual gold atoms as they formed into crystals, broke apart into individual atoms, and then reformed repeatedly into different crystal configurations before finally stabilizing.

Ercius said, "Slower observations would miss this very fast, reversible process and just see a blur instead of the transitions, which explains why this nucleation behavior has never been seen before."

The phenomenon occurs because crystal formation is an exothermic process- it releases energy. When atoms attach to the tiny nuclei, the very energy released can raise the local "temperature" and melt the crystal.

In this way, the initial crystal formation process works against itself, fluctuating between order and disorder many times before building a stable enough nucleus to withstand the heat.

The research team validated this interpretation of their experimental observations by performing calculations of binding reactions between a hypothetical gold atom and a nanocrystal.

One of the study's lead authors, Jungwon Park, summarized the work: "From a scientific point of view, we discovered a new principle of crystal nucleation process, and we proved it experimentally."

Scientists are now looking forward to developing more fast detectors which could be used to image the process at higher speeds.

This could help them in understanding if there are more features of nucleation hidden in the atomic chaos. **—Agencies**