

SHI YICHEN/XINHUA, VIA GETTY IMAGES

The Chinese Tianwen-2 spacecraft heading to the launchpad last month.

China's Space Collector

A robotic mission aims to gather samples from a near-Earth asteroid.

By ROBIN GEORGE ANDREWS

China has a space station and, in just a few short years, has landed robots on the moon and Mars. Now the country's space agency is targeting new, far-flung destinations and setting off for an asteroid that could contain clues to explaining how Earth and the moon formed.

The country's Tianwen-2 spacecraft lifted off aboard a Long March 3B rocket from the Xichang Satellite Launch Center in southwest China last Thursday, according to state media.

After about a year, the robotic mission will arrive at 469219 Kamoʻoalewa, a near-Earth asteroid. There, it will perilously try to scoop up some rocky matter, and then swing back around to Earth. A capsule filled with geologic treasure would then plunge toward the planet for retrieval by scientists in late 2027.

If Tianwen-2 pulls this off, China will become the third nation — after Japan and the United States — to retrieve pristine material from an asteroid.

"All Chinese planetary scientists are now finger-crossed for this historic mission," said Yuqi Qian, a lunar geologist at the University of Hong Kong.

The spacecraft also has a secondary target, an unusual comet that it could study as part of an extended mission.

Visiting these objects will help reveal more about the building blocks of the worlds of the inner solar system. And as asteroids can pose an impact risk to Earth, missions to study the structures and mineral makeups of these objects can aid planning to deflect or vaporize them.

"A sample return mission is a gift that keeps on giving," said Sara Russell, a planetary scientist at London's Natural History Museum.

While fragments of asteroids reach Earth's surface periodically, they are contaminated and altered when they plummet through the atmosphere. Scientists prefer untouched matter from the source, brought back to study in ultraclean laboratories.

"Sample return missions allow us to pick apart the physical and chemical properties of a body in a level of detail that's not possible with remote observations by telescopes and spacecraft," said Ashley King, a meteoriticist also at the London museum.

Japan has accomplished this twice, with its Hayabusa spacecraft raiding the asteroids Itokawa in 2005 and Ryugu in 2019. Osiris-Rex, NASA's sample return mission to the asteroid Bennu, pulled off the same feat in 2020.

China's space agency has executed two successful sample return missions to the moon — in 2020 and 2024. But Tianwen-2 (Tianwen is often translated as "Questions to Heaven") is China's first venture into asteroid sample return.

Kamoʻoalewa, the asteroid it will visit, is somewhat peculiar. As a quasi-satellite earlier known as 2016 HO3, it loops around Earth, but it is not a true moon, because it is gravitationally bound to the sun. Recent telescopic observations, though, suggest it is made of the same volcanic matter found on the moon, implying that it is a piece of the lunar surface shorn off by a meteor impact.

"Kamoʻoalewa, therefore, potentially holds key information about the formation and evolution of the Earth-moon system," Dr. King said.

However "its origins remain an open question," said Benjamin Sharkey, a planetary astronomer at the University of Maryland who made those recent telescopic observations. He said he was excited that Tianwen-2 was going to bring some of the asteroid home for study, which should close the case of Kamoʻoalewa's origins.

China has revealed few details about how Tianwen-2 will work. An academic paper posted last year offers some clues. A variety of cameras and infrared imagers will ascertain Kamoʻoalewa's shape, size, spin and mineral makeup, while a radar system will map its internal structure.

By looking at the thermal properties of Kamoʻoalewa, Tianwen-2 will also help study the Yarkovsky effect. When sunlight hits a rotating asteroid, its sunward side heats up. As it continues to spin, it cools down, which nudges the asteroid, like a small thruster. Over time, escaping heat can push a harmless asteroid onto an Earth-impacting orbit.

Kamoʻoalewa can get within nine million miles of Earth, making it an easy target to reach. But diving down to sample it is risky. "The sample collection and return are hardest," Dr. Russell said, "because humans have only a very limited amount of experience in doing both."

The asteroid may be only 130 feet across — a small target. Its rapid rotation, about once every 28 minutes, poses additional challenges. "You need to find ways to either grab the sample without landing or a way to hang on as it spins," Dr. King said.

China's spacecraft may try doing both. "Tianwen-2 will use two methods to collect samples from Kamoʻoalewa," Dr. Qian said.

The first is "Touch and Go," a method employed by the U.S. and Japanese asteroid missions: The spacecraft briefly makes contact with the object, kicks up the surface (using compressed gas, or a fired projectile) and captures jettisoned rocks before the spacecraft flees the scene.

If any rocky matter can be scooped up, it won't be delivered until 2027.

The second method, "Anchor and Attach," has never been tested. Using a series of drills, Tianwen-2 will try to adhere to the asteroid before retrieving both shallow and deeper samples.

If Tianwen-2 navigates those dangers and eventually drops its bits of Kamoʻoalewa to Earth, it will then fly to the Comet 311P/PanSTARRS, arriving in the early 2030s to study it remotely.

While most comets witnessed from Earth travel on long-haul journeys around the sun, 311P is a main belt comet. These icy curiosities stay within the asteroid belt between Mars and Jupiter.

"These types of objects remain very mysterious," Dr. Sharkey said, not least because icy rocks should not exist this close to the sun's warm glow. But they may help explain how Earth became a planet with vast oceans.

Tianwen-2 is more than just a scientific sleuth. It is also a technological steppingstone for China's ambitious Tianwen-3 mission. Scheduled to launch in 2028, it aims to retrieve rock samples from Mars and return them to Earth. A comparable effort led by the United States to achieve the same goal is facing major hurdles.

But the race for the red planet should not overshadow China's first bid to acquire shards of an asteroid.

"This is very exciting," said Richard Binzel, a planetary scientist at the Massachusetts Institute of Technology. "But asteroids present their own challenges."

New Bid to Save Injured Brains

Neurology experts join forces to create a system for patients with signs of trauma.

By GINA KOLATA

Dr. Geoffrey Manley, a neurosurgeon at the University of California, San Francisco, wants the medical establishment to change the way it deals with brain injuries. His work is motivated in part by what happened to a police officer he treated in 2002, just after completing his medical training.

The man arrived at the emergency room unconscious, in a coma. He had been in a terrible car crash while pursuing a criminal.

Two days later, Dr. Manley's mentor said it was time to tell the man's family there was no hope. His life support should be withdrawn. He should be allowed to die.

Dr. Manley resisted. The patient's brain oxygen levels were encouraging. Seven days later the policeman was still in a coma. Dr. Manley's mentor again pressed him to talk to the man's family about withdrawing life support. Again, Dr. Manley resisted.

Ten days after the accident, the policeman began to come out of his coma. Three years later he was back at work and was named San Francisco Police Officer of the Month. In 2010, he was Police Officer of the Year.

"That case, and another like it," Dr. Manley said, "changed my practice."

But little has changed in the world of traumatic brain injuries since Dr. Manley's patient woke up. Assessments of who will recover and how severely patients are injured are pretty much the same, which results in patients being told they "just" have a concussion, who then have trouble getting care for recurring symptoms like memory lapses or headaches. And it results in some patients in the position of that policemen, who have their life support withdrawn when they might have recovered.

Now, though, Dr. Manley and 93 others from 14 countries are proposing a new way to evaluate patients. They published their classification system last month in the journal Lancet Neurology.

The system is the result of a request made three years ago by the National Academies of Science, Engineering and Medicine, for experts to reconsider how they characterize traumatic brain injury patients. That led to a group that was put together by the National Institute of Neurological Disorders and Stroke.



ZEPHYR/SCIENCE SOURCE

A CT brain scan of a male patient who suffered a traumatic brain injury after a car crash.

Traumatic brain injuries are typically caused by auto accidents, falls and assaults. They kill more than 69,000 people a year in the United States. More than 5.3 million Americans who have survived a traumatic brain injury live with a lifelong or long-term disability as a result.

For decades, doctors used the Glasgow Coma Scale to evaluate patients' consciousness and make prognoses. The test assesses a person's ability to respond to commands, whether their pupils react to light and other factors. Patients' injuries are categorized as mild, moderate, or severe.

But that sort of assessment is insufficient today, said Dr. Michael McCrea, a member of the group proposing the new classification and professor of neurosurgery at the Medical College of Wisconsin. It sounds, he said, "like a cartoon," to evaluate patients by asking, for example: "How many fingers am I holding up? What city are we in?"

"We know we can do much better than the age-old mild, moderate, severe categories," he said. "It's really just embarrassing."

"Mild" traumatic brain injuries are often not mild; patients can have continuing problems, Dr. McCrea said. And, he added, some with "severe" injuries can achieve full recoveries.

"What you call someone dictates their care," Dr. Manley said.

Dr. Manley said that using only the coma scale also made research more difficult. He remembers "a flurry of clinical trials," he said, more than 30, that had failed in part because "the classification system is terrible." They made it difficult to know if patients in a study had suffered similar injuries and whether a treatment had helped, he said.

"What if I were to go to the F.D.A. and say, 'I am doing a cancer trial for "severe" cancer'? They would look at me and say, 'What are you talking about?'" Dr. Manly said.

The newly proposed standards start with the Glasgow scale, but add other signs, like whether patients have post-traumatic amnesia or headaches or are sensitive to light or noise.

But the new system also looks for blood biomarkers of brain injury and includes scans, including CT and M.R.I.s to look for blood clots, skull fractures and hemorrhaging.

Another part of the classification system considers the person's social environment.

Two patients might have the same injury, Dr. McCrea said, but one is homeless, a substance abuser and has PTSD. The other has extensive family support, no substance abuse problems and has good mental health.

The first patient, he said, will have "a much tougher road and a significantly greater risk of a poor outcome."

The hope is to end the medical reliance on oversimplified testing. A better classification system will help researchers develop drug treatments and better procedures, Dr. McCrea said.

He was especially enthusiastic about adding blood tests to the mix.

Suppose, he said, someone was in a car crash in a rural area, and had clear signs of a brain injury. Hours could be wasted waiting for a CT scan at a local hospital before the patient was transported to a regional trauma center.

"Imagine, instead, doing a blood biomarker test in the ambulance," he said. If the test indicates severe damage the person would be taken to the trauma center immediately.

"Time is brain," Dr. McCrea said.

"We all grew up with the categories, 'mild, moderate, severe,'" he said. "We can do better than that."

Scientists Discover a Dwarf Planet

The findings, which are not yet peer-reviewed, cite an object that travels a 'very exotic orbit.'

By KENNETH CHANG

A sizable world has been found in a part of the solar system that astronomers once thought to be empty. It probably qualifies as a dwarf planet, the same classification as Pluto.

Temporarily named 2017 OF201, it takes more than 24,000 years to travel around the sun once, along a highly elliptical orbit, coming as close as 4.2 billion miles and moving as far out as 151 billion miles. (Neptune is 2.8 billion miles from the sun.)

And 2017 OF201 may have implications for the hypothesis of an undiscovered planet, nicknamed Planet Nine, in the outer reaches of the solar system.

"We discovered a very large trans-Neptunian object in a very exotic orbit," said Sihao Cheng, a researcher at the Institute for Advanced Study in Princeton, N.J.

The findings, by Dr. Cheng and two Princeton University graduate students, Jiaxuan Li and Eritas Yang, have not yet been published in a peer-reviewed journal.

Estimated to be about 430 miles wide, 2017 OF201 is probably massive enough for its gravity to pull it into a round shape — the criterion for a dwarf planet. The International Astronomical Union created this category in 2006 when it dropped Pluto from the roster of full-fledged planets.

Like Pluto, 2017 OF201 would not meet the threshold to be called a planet because it is not large enough to have "cleared its neighborhood" of other objects near its orbit.

Dr. Cheng became intrigued by the far out region of the solar system after listening to a talk last year by Mike Brown, an astronomer at the California Institute of Technology. In 2005, Dr. Brown discovered Eris, a Pluto-size world beyond Pluto, which set off a series of events leading to Pluto's demotion.

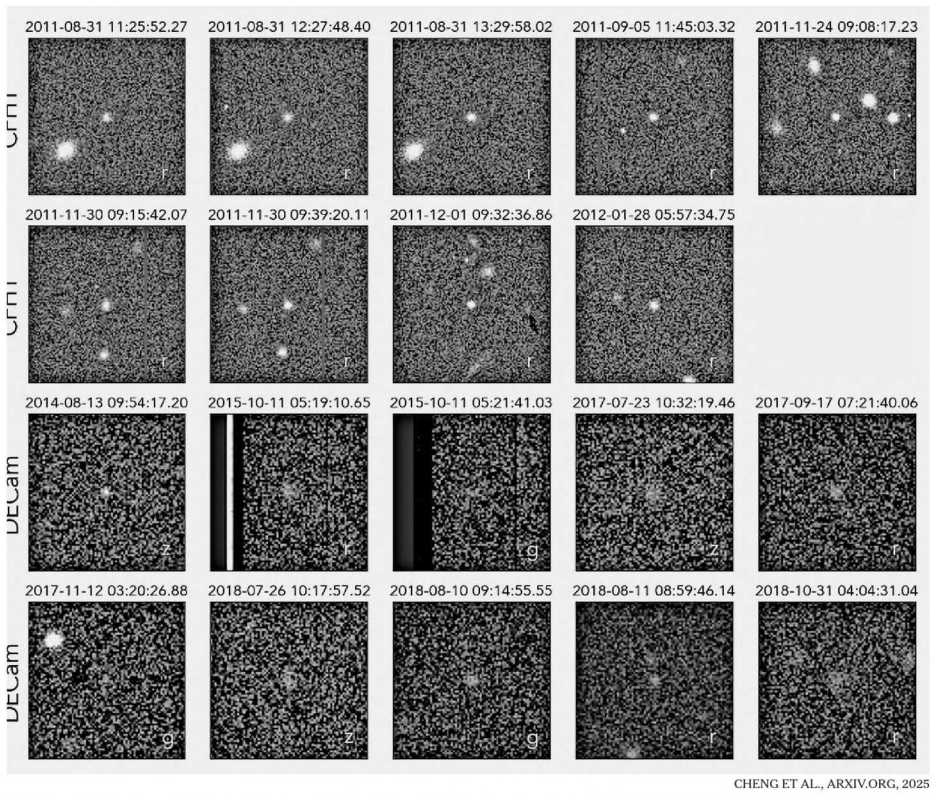
The astronomical union has officially recognized only five dwarf planets: Pluto, Eris, the large asteroid Ceres and two other objects beyond Neptune, Haumea and Makemake. But according to Dr. Brown, more than 100 other solar system bodies are likely to qualify, although definitive evidence of roundness is unlikely anytime soon.

Dr. Brown also discovered Sedna, a surprisingly large world — more than 700 miles wide — that orbits the sun far beyond the orbit of Neptune. Over the years, more of these worlds, which are sometimes called extreme trans-Neptunian objects, have been identified.

Dr. Brown and Konstantin Batygin, also of Caltech, have asserted that the orbits seem to align in a particular direction, and have said that points to the gravitational tugging of an unseen planet several times larger than Earth — Planet Nine. But so far, searches for Planet Nine have come up empty.

Dr. Cheng decided to search, too. His coauthor Mr. Li suggested delving into an archive of images taken by the Blanco telescope in Chile.

Dr. Cheng spent half a year writing a computer program to recognize that dots in different images taken months apart were actually the same object that had moved in the sky.



CHENG ET AL., ARXIV.ORG, 2025

All 19 detections of the dwarf planet 2017 OF201, from August 2011 to October 2018.

"The motion of these objects on the sky follow a particular pattern," Dr. Cheng said. But the permutation of possible dots, which could also be closer objects like asteroids or random noise in the sensors, was daunting. He came up with a clever algorithm.

"It's still a lot of computation," Dr. Cheng said. "Just from impossible to possible."

While their search also failed to find Planet Nine, the dots connected for 2017 OF201.

The researchers subsequently found nine more sightings in images taken years earlier by the Canada-France-Hawaii Telescope in Hawaii. That allowed a precise calculation of the orbit. The last time 2017 OF201 made its closest approach to the sun was in 1930, the year that Pluto was discovered. It will not be that close again until around the year 26186.

From its brightness and an assumption of the darkness of the surface, the researchers estimated its size.

Dr. Cheng originally calculated that the orbit roughly fit with the alignment proposed by Dr. Brown and Dr. Batygin. But after Mr. Li pointed out a mistake in Dr. Cheng's calculations, they determined that the elliptical orbit was oriented in a different direction.

"And then we realized the orbit of this thing looks kind of weird," Mr. Li said. "We started to realize, Can we say something about the history of this object and also maybe its implication on the existence of a Planet Nine?"

Numerical simulations by Ms. Yang, the other author of the paper, looked at how the orbit of 2017 OF201 could have changed over the 4.5 billion-year history of the solar system, and how it might change in the years to come.

Ms. Yang found that its orbit would remain stable for the next billion years or so — if there were no Planet Nine. But a Planet Nine would nudge the closest part of 2017 OF201's trajectory inward until Neptune flung it out of the solar system.

That would happen pretty quickly, within about 100 million years. If Planet Nine were there, 2017 OF201 should not be there. Because 2017 OF201 is there, that could be an argument that Planet Nine is not.

But Ms. Yang's simulations considered only one possible orbit for Planet Nine. It is also possible that 2017 OF201 was pushed into its current orbit in the fairly recent cosmological past.

"It doesn't mean too much, actually, because the object is unstable," Dr. Batygin said.

Dr. Cheng said he still thought Planet Nine was possible. But Mr. Li said that when he plotted the orbit, "I thought, OK, this kills Planet Nine."

He agreed that the simulations were not definitive, but joked, "It's 49 percent killed."

Ms. Yang said she was neutral on Planet Nine's existence. "I'm just excited that there's lots more to be worked on this," she said.

Another new study, by researchers at Rice University and the Planetary Science Institute, suggests how something as big as Planet Nine could have ended up so far from the sun.

Such "wide orbit" planets have been spotted around other stars, so it is conceivable that the solar system had one too, said Andre Izidoro, a planetary astrophysicist at Rice and the lead author of the study.

As a planetary system forms around a star, the gravitational jostlings of the planets can scatter some of them into highly elliptical orbits and eventually into deep space.

However, stars like the sun are typically born in dense star clusters, and another passing star can nudge a planet that would otherwise be flung out of the system into a stable orbit that no longer comes close to the other planets.

"The passing star essentially saves the planet," Dr. Izidoro said.

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