

China's Mars Exploration Mission Will 'Leapfrog' Space Development

by Marsha Freeman, Technology Editor

July 28—China's first interplanetary spaceship is now on its way to Mars. Launched in the early morning of July 23, *Tianwen*, or "Questions to Heaven," now has a seven-month cruise to its destination. It will be traveling alongside the small UAE *Hope* orbiter, launched on July 20 and, if all goes as planned, the U.S. spacecraft *Perseverance*, which is now slated for a July 30 departure.

At a time when there is increased tension among nations, leaders of space agencies—along with astronauts and cosmonauts—have stressed that in space, there are no such tensions. Everyone has the same goals—scientific and technological advance—which cannot be achieved unless everyone works together, especially in missions to Mars, which are highly complex.

In an atmosphere in the press largely supportive, if not impressed, with the *Tianwen* mission, and with international attention on China's high-risk Mars mission, NASA Administrator Jim Bridenstine tweeted:

With today's launch, China is on its way to join the community of international scientific explorers at Mars. The United States, Europe, Russia, India, and soon the U.A.E. will welcome you to Mars to embark on an exciting year of scientific discovery. Safe travels *Tianwen-1*!

China's 'Leapfrog'

Every country that has sent spacecraft to other planets has followed a step-by-step approach, minimizing risk and maximizing science return. Planetary exploration in the 1960s mainly consisted of just flying by, taking mostly fuzzy photographs of a planet. By the 1970s, a spacecraft could go into orbit around the planet, staying there even for years, gathering more detailed basic data over time. On Mars, unlike the Moon,

there are seasonal changes and other dynamic characteristics that can only be observed over time. The orbiting satellites provide the data which are crucial for the next step—landing. Finally, the lander can be reconfigured to move, and with some changes, you have a rover. The Chinese, who have never been to Mars, decided to do all three steps on the first try.

There are two classes of goals for *Tianwen*—technological breakthroughs and the science itself. This



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Launched July 23, 2020, China's *Tianwen-1* Mars mission spacecraft is shown here being assembled. The mission includes an orbiter and a lander-rover; its instruments will conduct experiments across more than a dozen scientific disciplines.

first Chinese Mars mission should make "breakthroughs in key technologies," to lay the basis for more complex future Mars missions. These include braking, to allow the spacecraft to be captured by Mars' gravity; entry, descent and landing, described as the "seven minutes of terror" when NASA's *Curiosity* rover came through Mars' atmosphere to land; long-term autonomous management; long-distance communication; and surface inspections by the rover.

Tianwen, both the orbiter and the rover, are outfitted with suites of scientific instruments to allow the spacecraft to meet five scientific goals encompassing more than a dozen scientific disciplines. These include:

- Topography, geomorphology and geological structure of the global area of the whole planet, and of the potential landing area for the rover
- Thickness, composition and distribution of soil planet-wide and in the landing zone
- Groundwater distribution and water ice data
- Detailed investigation of key candidates for landing areas
- Mars' magnetosphere, ionosphere, atmosphere, and its climate characteristics.

Chinese scientists have designed the mission to give the orbiter time to provide a detailed mapping of both global characteristics and those of potential landing sites for the rover. The rover, for its part, will spend up to three months in orbit before it is released to land, increasing the chance for success. (Mars is littered with the 50% of the missions that failed.)

Why Mars?

If there were anyone who would be able to answer questions about the mission, it would be China's most well-known space scientist, Ouyang Ziyuan, the scientist known as the father of Chang'e, China's lunar exploration program. When a number of reporters sat down to talk with the 85-year-old scientist, he told them,

I am very excited.... This is a historic day in the history of China's spaceflight, and a milestone event. It marks China's spaceflight entering the era of planetary exploration. The dream of our generation has finally come true.

The realization of Mars circumnavigation, landing, and roving through a single mission, to achieve leapfrog development, is the characteristic of China's Mars exploration. Although China's Mars exploration started late, it has a high starting point, and achievement.

For decades, Ouyang led the lunar campaign, producing numerous scientific studies and lobbying the government for the Chang'e lunar exploration program. What was his rationale now for missions to Mars? Ouyang explained that if mankind wants to fly into wider space to explore further, the first step is to land on the Moon, and the second step is to explore Mars:

Mars exploration is the current focus of global space exploration. Mars is the sister of the Earth. We are going to study the origin and evolution of Mars. What everyone is most concerned about is whether there is life on Mars. The search for life on Mars has always been the first scientific goal of Mars exploration.

Ouyang Ziyuan said that Mars exploration has always been a high-risk mission. In his view, in the past few decades, mankind has explored Mars 47 times, and the success rate is only half. Scientists have held international conferences to discuss the long-term transformation of Mars and the prospects of establishing a second human habitat in the future, he said. The first step to transforming the Martian environment is to increase the surface temperature of Mars, let the ice cap melt, maintain liquid water on the surface, and create a greenhouse effect. Then plant some low-grade plants to slowly change the structure of the atmosphere, bringing the temperature of Mars closer to that of the Earth. According to current scientific understanding, this process will take about 100 to 200 years. In fact, Ouyang himself wrote a book on this subject, *Recreating an Earth: The Road to Mankind Transforming Mars*.

Engaging the Next Generation

To engage the interest of the public, and particularly young people, China has built a "Mars camp," or simulated base, where primary and high-school students can undergo simulated astronaut training and learn survival techniques in space. Tourists and the media are also welcome to visit.

The camp, which opened in March 2019, is built on an 80-acre site in a Mars-like, desert region in the upper reaches of the Qinghai-Tibet plateau, near Lenghu town. It is separated into a Mars landing site and a camp area with a tent and cabins, or "sleeping capsules." The camp can accommodate 160 people.

The camp teaches astronomy and astrophysics to the young students, but 30 telescopes will also be built there for the use of scientific institutions and universities. The location is ideal for astronomical observing, as the air is dry and the sky always clear. The plan is to make the entire area a venue for scientific research.

"I always feel that a country and a nation must have people looking up at the stars, so that this nation has hope," says Ouyang Ziyuan.