Japan orbiter seeks second shot at Venus

Five years after a failed insertion into planet's orbit, Akatsuki tries again.

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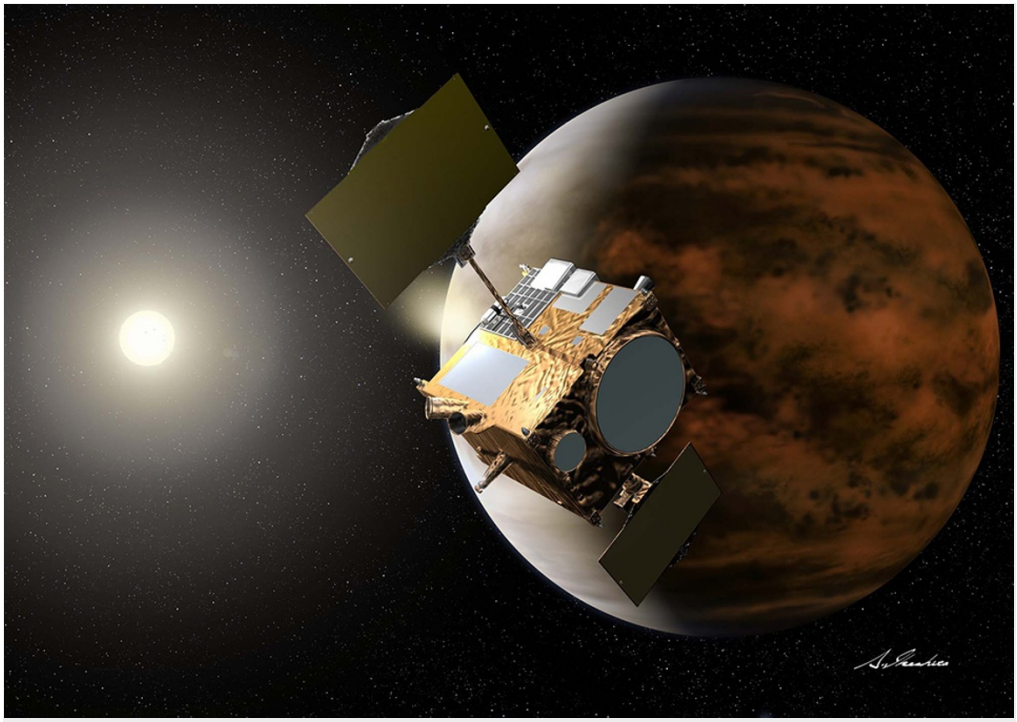


Akihiro Ikeshita/JAXA

The Akatsuki probe has spent five years orbiting the Sun.

Update, 7 December (1:40 a.m. BST): *Japan's Akatsuki mission has entered orbit around Venus (see our news story). The spacecraft burned its engines as planned on 7 December and was captured by Venus's gravity, says team member Sanjay Limaye, a planetary scientist at the University of Wisconsin in Madison. Over the next two days, mission scientists will track the spacecraft and determine how closely the orbit matches what scientists had hoped for. That information is expected to be released at 6 p.m. Japan time (9 a.m. BST) on 9 December.*

Japan's Akatsuki spacecraft, whose name means 'dawn', gets a second chance to rise on 7 December. Exactly five years after it failed to slip into orbit around Venus, Akatsuki will fire its engines and try again.

The spacecraft has spent the past half-decade orbiting the Sun, on its way to catch up with Venus. "It's been quite a long period of waiting," says Masato Nakamura, project manager at the Japan Aerospace Exploration Agency (JAXA) Institute of Space and Astronautical Science in Sagamihara.

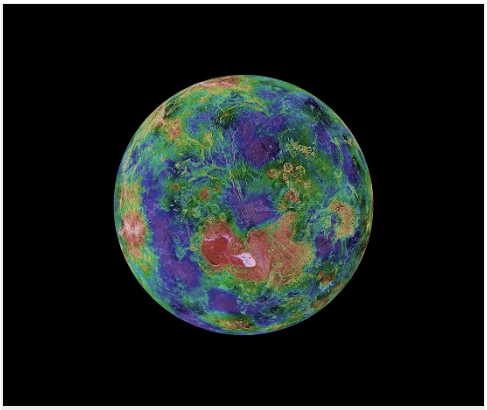
Just before 9 a.m. Japan time on 7 December, engineers will command Akatsuki to fire four of its thrusters simultaneously. The engines will run for around 20 minutes, aiming to nudge the spacecraft onto the correct trajectory for capture by Venus's gravity.

Mission controllers expect to know within a few hours whether the propulsion burn went as expected. It may take a few days after that to confirm whether Akatsuki is indeed orbiting Venus.

If it works, the spacecraft will end up in a highly elliptical orbit, more stretched out and farther from Venus than was originally planned. This would put the orbiter several thousand kilometres away at its closest approach, rather than several hundred. From there, Akatsuki should be able to accomplish most of its original science goals, although data will take longer to accumulate.

"The past five years have been a tough period for us — tracking of a spacecraft which does not yield science data is not fun for

scientists," says team member Takeshi Imamura. "Now we are nervous, but at the same time very excited. Venus is a stone's throw from us."



NASA/JPL/USGS

Venus is shown here in a false-colour radar image.

Dawn breaks

Akatsuki was launched in May 2010 on a mission to study Venus's ever-changing atmosphere, which rotates at up to 100 metres per second — much faster than the planetary surface below it. The spacecraft carries five cameras, ranging from infrared to ultraviolet wavelengths to study different atmospheric features, including the lightning thought to flash through Venus's acidic clouds.

All seemed well until 7 December 2010, when the spacecraft fired its main engine to enter Venus's orbit. Unknown to mission controllers, salt had built up on a valve between a helium tank and a fuel tank, and the blockage caused a ceramic nozzle in the propulsion system to break. Akatsuki went sailing towards the Sun, rather than into orbit around Venus.

JAXA engineers spent years studying whether they could recover the mission[1]. With the main engine dead, the oxidizer fuel was also useless, so mission controllers dumped 65 kilograms of fuel into space in October 2011. This made the spacecraft lighter and easier to manoeuvre, which should enable it to reach orbit with less thrusting.

The upcoming engine burn will involve four of the spacecraft's eight thrusters. These smaller engines are normally used to make minor adjustments to the probe's orientation, as opposed to major changes to its trajectory. Because the thrusters are lower power than the main engine, they will need to burn for longer than usual. JAXA has tested them several times in deep space, most recently in September. If the thrusters work as well in the upcoming burn as they did in testing, "we are confident that the propulsion will be successful", Imamura says.

High noon

But the spacecraft's unexpected detour may still cause problems. Because it has spent more time closer to the Sun than originally designed, Akatsuki is warmer than expected, which may have harmed some of its equipment; this could limit operations at Venus.

During its five years in deep-space wilderness, Akatsuki conducted a little science, such as transmitting radio signals to Earth through the solar corona to measure how the Sun's turbulence scatters radio waves[2]. But the craft's cameras have mostly remained off.

Manoeuvring Akatsuki into Venus's orbit would give scientists their only chance at seeing the planet up close for the foreseeable future. The European Space Agency's Venus Express spacecraft stopped working a year ago, after eight years of circling the planet in a polar orbit. (If Akatsuki succeeds, it will be in an equatorial orbit and so permit different views.) NASA has put two Venus probes on its shortlist of five candidates for the next Discovery-class mission, which would launch no earlier than 2020.

JAXA has a history of nail-biting second chances. The Hayabusa spacecraft survived a number of near-fatal incidents on its way to and from collecting samples of the asteroid Itokawa. But in 2003, after an extended effort to make the mission work, JAXA lost its Mars-bound Nozomi spacecraft, first to a problem with a fuel valve and then to a solar flare that fried its electronics.

Sanjay Limaye, an Akatsuki participating scientist at the University of Wisconsin–Madison, says that the team is ready for something to work for once.

"Whatever could go wrong has already gone wrong," he says. "What's left?"

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Updates

Updated: Updated with news of Akatsuki's successful attempt to reach orbit around Venus.

References

1. Nakamura, M. *et al*. *Acta Astronautica* **93**, 384–389 (2014).

2. Imamura, T. *et al*. *Astrophys. J.* **788**, 117 (2014).