



NASA's Pioneer Venus Orbiter captured this ultraviolet image of Venus's clouds in 1979.

the phosphine claim⁴. “This makes the whole debate about phosphine, and possibly life in the atmosphere of Venus, quite irrelevant.”

Jane Greaves, an astronomer at the University of Cardiff, UK, who led the team that made the original phosphine claim, says she and her colleagues will comment after they've finished evaluating the new papers.

The stakes for confirming phosphine's presence on Venus are huge. On Earth, the gas can come from industrial sources such as fumigants, or from biological sources such as microbes. When first reporting the discovery of phosphine on Venus, Greaves and her colleagues said that its existence might mean there was life on the planet, because other origins for the gas weren't obvious.

But the claim rests on a chain of observations and deductions that other scientists have been chipping away at in recent months.

Greaves's team first used the James Clerk Maxwell Telescope (JCMT) in Hawaii to observe a spectral line in Venus's atmosphere at a frequency of 266.94 gigahertz – around the frequency where both phosphine and SO₂ absorb light. The scientists confirmed the existence of the line using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile. With ALMA, they looked for other spectral signatures that they would expect to see if the line came from SO₂, and did not

find them. This, they said, suggested that the line at 266.94 gigahertz came from phosphine.

But it turned out that the ALMA data the team had used had been processed incorrectly by the observatory. After the debate over phosphine on Venus began, managers at ALMA realized the mistake, reprocessed the raw data and released the reworked batch in November.

Greaves and her colleagues analysed the reprocessed data and concluded that they were still seeing phosphine – albeit at a much lower level than they had reported at first⁵.

Those reprocessed ALMA data are at the heart of one of the new studies challenging the claim. A team including Meadows and led by Alex Akins, a research technologist at the Jet Propulsion Laboratory in Pasadena, California, aimed to replicate the work of Greaves's group. But the researchers didn't observe phosphine's spectral line when they analysed the reprocessed data released to the public. “We just weren't able to see it,” says Akins.

The second study explores the 266.94-gigahertz feature, as seen by the JCMT. Andrew Lincowski, an astronomer at the University of Washington, led Meadows, Akins and others in modelling the structure of Venus's atmosphere at various altitudes. They found that the JCMT observation was best explained by the presence of SO₂ more than 80 kilometres above the planet's surface – not by phosphine at 50–60 kilometres above the surface, as Greaves's team claimed.

Still, although the new studies argue against the presence of phosphine, they can't entirely rule it out. “There's enough wiggle room there,” says Meadows.

Ultimately, says Akins, the debate can be resolved only with fresh observations of Venus, many of which are planned in the coming months and years.

1. Greaves, J. S. et al. *Nature Astron.* <https://doi.org/10.1038/s41550-020-1174-4> (2020).
2. Akins, A. B., Lincowski, A. P., Meadows, V. S. & Steffes, P. G. Preprint at <https://arxiv.org/abs/2101.09831> (2021).
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4. Snellen, I. A. G., Guzman-Ramirez, L., Hogerheijde, M. R., Hygate, A. P. S. & van der Tak, F. F. S. *Astron. Astrophys.* **644**, L2 (2020).
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FAMED CHINESE SCIENTIST CLEARED OF PLAGIARISM AND FRAUD

But Cao Xuetao will face ramifications for 'misused' images found in his group's papers.

By David Cyranoski

A distinguished Chinese immunologist, Cao Xuetao, has been cleared of significant wrongdoing, more than a year after the government launched an investigation to review 63 manuscripts he co-authored that contained

suspected problematic images. The investigating committee found that none of the papers contained plagiarized or fabricated data, but that some had images that had been “misused”, which “reflected a lack of rigorous laboratory management”. Cao must now correct those papers and has been barred from applying for grants or recruiting students for a year.

Research leaders in China have been cracking down on problematic research for several years, following ongoing issues with plagiarism and research misconduct. Cao, now the president of Nankai University in Tianjin, China, and a prominent voice for strengthening research integrity in the country, is among the most high-profile scientists to be investigated. The papers in question were published before he became university president.

The investigating committee, comprising representatives from the ministries of science and education, and several other government agencies, published a summary of its conclusions online on 21 January. However, it gave few details about the investigation, including how many of Cao's papers contained misused images. Several scientists contacted by *Nature* criticized this lack of transparency; others disagreed with the committee's findings.

"It is astonishing that [the committee] concluded that no fraud had been committed in any of these cases," says Elisabeth Bik, a microbiologist based in the San Francisco Bay Area, California, who first raised issues about Cao's papers in November 2019, triggering the investigation. Bik devotes her time to spotting problematic images in scientific papers.

Bik says that in some of Cao's papers, the same images have been used to represent different experiments, which could have been accidental. "That is sloppy, but does not necessarily mean it was done intentionally," she says. But other papers contain images with unnaturally repetitive elements. "I cannot think of any technical reason or failure to correctly label images that could explain those repeats," she says. "The images appear to be altered."

Huang Futao, who studies higher education at Hiroshima University in Japan, says Cao should now explain why there are so many problematic images in his papers, and what measures he will take to prevent similar problems in the future.

Gruelling investigation

Cao says the investigation was gruelling. He and his colleagues gave the investigation 1,500 pages of material, some stretching back more than 15 years, including repeated experiments and new data that have been submitted for publication. Cao says he was corresponding author on 54 of the papers investigated, and that 35 contained unintentional errors resulting in image misuse. He blames the lack of "unified definitions and journal policies regarding image processing" 10–15 years ago, when the problematic papers were published. "What are classified as 'errors' today might not be considered errors back then but instead, acceptable practices," he says. Cao did not respond to Bik's suggestion that some images looked intentionally altered.

In November 2019, Bik raised concerns on the academic discussion forum PubPeer



Immunologist Cao Xuetao has been barred from applying for grants for a year.

about problematic images in dozens of papers written by Cao and his group. Several other people, mostly anonymous, raised similar issues in other papers from the group. At the time, Cao said his lab would investigate the issues raised and was confident they did not alter the paper's conclusions. Some of Cao's co-authors replied on PubPeer that some mistakes were honest errors, such as images being mislabelled.

As a result of the investigation, the committee ordered Cao to respond to the concerns in

"I cannot think of any technical reason or failure to correctly label images that could explain those repeats."

the papers in question and carry out corrections. According to a *Nature* analysis, 19 have been corrected and 3 have been withdrawn since Bik first flagged the papers. Cao has also been prevented from applying for national science and technology projects, and from acting as a scientific expert in any activities using government funds.

Cao says he will improve data-archiving and image-processing procedures in his lab. "We're confident that with more stringent and updated data management and education, we'll continue to make positive contributions to the advancement of human health and disease research," he says.

Bik says that the most important upshot of the investigation is the committee's instruction to Cao to retract or correct the papers in question – but she is concerned that more papers have still not been retracted.

Sun Ping, a former research-integrity officer at China's science ministry who now consults on research integrity at Siyidi International Education Consulting and Service in Beijing, would like the committee to make details of its investigation public. "If the investigation report can be made public, the interested readers will make their own judgements," says Sun.

Others investigated

The committee also released its findings on several other researchers' papers that had been flagged for problematic images. It found no evidence of fraud in papers by Li Hongliang, a cardiovascular researcher and dean of the School of Basic Medical Sciences at Wuhan University in China, but did identify misuse of images that "reflected the lack of rigorous processing of experimental data". Li will face the same penalties as Cao, but they will last for two years.

The committee also found no evidence of fraud in papers by Geng Meiyu, a pharmacologist at the Shanghai Institute of Materia Medica, China, who gained fame with a controversial and contested finding that suggested a seaweed extract can slow decline in people with Alzheimer's disease, but reprimanded her for incorrect use of images in papers. Nor did it find evidence of fraud in papers by Pei Gang, a molecular biologist at the Shanghai Institute of Biochemistry and Cell Biology, China, and by Rao Yi, a neuroscientist at Capital Medical University in Beijing.

Li, Geng and Rao did not respond to requests for comment on the committee's findings. Pei says the investigation into his papers was a waste of resources. "I still want to know what the evidence was that started this," he says.