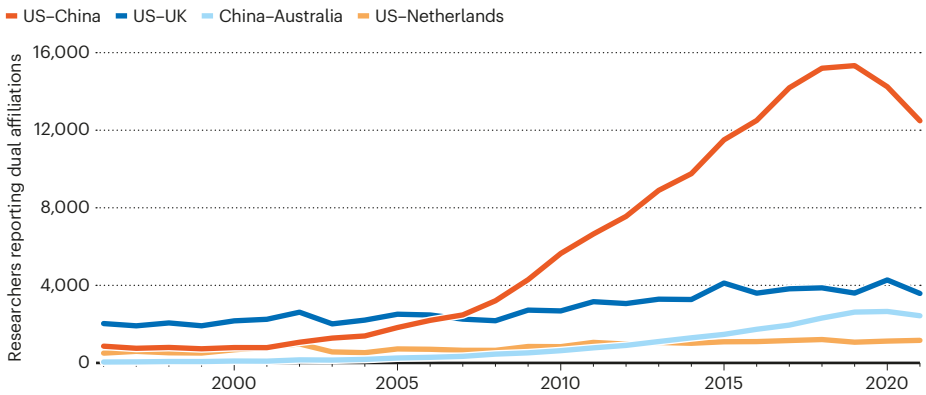
## DUAL AFFILIATIONS

The number of researchers reporting affiliations in both the United States and China has fallen sharply.




SOURCE: J. BAAS/SCOPUS (JOURNAL AND CONFERENCE PAPERS, BOOKS AND REVIEW ARTICLES).

the number of authors who reported a dual US–China affiliation on at least one publication in a year had risen to more than 15,000 by 2018, but had dropped to below 12,500 by 2021 (see 'Dual affiliations'). This fall was more sustained than for other pairs of nations, Baas found, and it occurred even as the global number of authors disclosing multiple affiliations continued to rise.

The pattern might help to explain how publications with co-authors from China and the United States also fell in 2021, the Scopus figures show, even as total US and Chinese outputs are both increasing. Baas's analysis suggests that there has been a much sharper fall among the subset of these publications that have dual-affiliated authors.

In February, Caroline Wagner at the Ohio State University in Columbus and Xiaojing Cai at Yangzhou University in China used data from the Web of Science to show that US–China co-authored papers were falling as a share of world publications, whereas papers with co-authors from China and the European Union were not. They also published a table suggesting that the number of papers with dual-affiliated US–China authors has had a sharper fall (C. S. Wagner and X. Cai Preprint at https://arxiv.org/abs/2202.00453; 2022).

### Pandemic and politics

Zhang and five other specialists contacted by *Nature* said that greater politicization of US–Chinese science, as well as the pandemic, was playing a part. As early as 2015–16, Zhang says, it became harder for foreign academics to get visas approved to visit China, and for Chinese researchers to travel overseas. And from 2018, the US government's China Initiative started to investigate hundreds of US-based scientists over their collaborations in China. Researchers say that together with more onerous US visa restrictions and tightened export controls, this programme has dampened bilateral US–China research partnerships and dissuaded scientists in China from visiting the United States. The initiative was effectively terminated this year, but China is included in a broader US Department of Justice 'strategy for countering nation-state threats'.

In 2021, a survey of nearly 2,000 scientists in the United States found that about half of respondents of Chinese descent experienced fear or anxiety that they were being surveilled by the US government, and were more likely than non-Chinese scientists to say they had stopped collaborations with researchers in China over the past 3 years. "My overall concern on the US side is the extent to which collaboration with China is being criminalized, even post-China Initiative," says Jenny Lee, a social scientist at the University of Arizona in Tucson, who was one of the co-authors of the survey.

She and John Haupt, also at the University of Arizona, have been interviewing US-based and China-based scientists to study how they collaborated on COVID-19 research. Their work, not yet published, shows that pandemic-related travel and visa restrictions prevented many Chinese scientists from visiting the United States — and the researchers also reported political restrictions.

### Academic courtesy

Dual affiliations needn't always signify dual employment or funding, says Li Tang, a science- and innovation-policy researcher at Fudan University in Shanghai, China. They might be reported as a courtesy by an academic to an institution they visited that gave them research assistance, or at the visited institution's request, she notes.

Data gleaned from research papers are also a lagging indicator of actual activity, because publications might not appear until years after a study was done. And the specific reasons for the dual-affiliation decline might vary between disciplines, notes Zhang. Still, she says it's reasonable to suspect that deteriorating political relations have led to researchers and universities in both countries hesitating to initiate and strengthen collaborations.

# HOW SATELLITE SWARMS POSE A RISING THREAT TO ASTRONOMY

SpaceX and other companies are still struggling to make their satellites darker in the night sky.

**By Alexandra Witze**

It's been three years since SpaceX, an aerospace company in Hawthorne, California, launched its first batch of Starlink Internet-communication satellites, sparking concern among astronomers about the streaks the satellites leave in photographs of the night sky. Since then, many other Starlinks have launched: more than 2,300 of them now orbit Earth, comprising nearly half of all operational satellites.

Scientists have made some progress in coping with the onslaught. For instance, the International Astronomical Union (IAU) plans to soon debut a website including tools to help telescope operators predict satellite locations so that they can point their instruments elsewhere.

But accumulating evidence reveals just how much these satellite 'megaconstellations' will interfere with astronomical observatories and other skywatchers around the globe. And satellite companies have not yet found a solution. SpaceX had been trying to address the problem by putting sun-blocking shades on its Starlinks to dim their appearance in the night sky. But *Nature* has learnt that the company has stopped doing so.

Tens of thousands of new satellites could be launched in the next few years. "This is an unsustainable trajectory," says Meredith Rawls, an astronomer at the University of Washington in Seattle. "At the moment, our science is fine. But at what point will we miss a discovery?"

Since the first Starlinks launched, astronomers have gone from panicking about the satellites photobombing scientific observations

to organizing a global response. After a series of international workshops in 2020 and 2021, the IAU set up a Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference. Its soon-to-be-launched website is meant to serve as a hub for coordinating how to reduce the impacts of satellites blazing through the skies.

A recent study suggests that future satellite constellations will be the most visible during summer nights at latitudes of around 50 degrees south and 50 degrees north, where many European and Canadian astronomical facilities are based[1]. If SpaceX and other companies launch the 65,000 satellites they have proposed, bright dots will buzz across the skies all night long at those latitudes around the summer solstice, the study says. In the hours around sunrise and sunset, about one in every 14 stars visible to the naked eye will actually be a satellite.

"It's really quite horrifying," says Samantha Lawler, an astronomer at the University of Regina in Canada, who led the work.

M. LEWINSKY (CC BY 2.0)

**Starlink satellites streak (vertically) across a time-lapse photo of the night sky.**

## A busy sky

Astronomical observatories that study wide expanses of the sky, rather than focusing on individual celestial objects, will be most affected. The Zwicky Transient Facility, which surveys wide swathes of the sky using a 1.2-metre telescope on Palomar Mountain, California, had satellite streaks in 18% of its images taken during twilight in August 2021 (ref. 2). And that number has gone up as satellite numbers have increased, says lead author Przemek Mróz, an astronomer at the University of Warsaw. He ran a preliminary analysis of the telescope's data from April 2022 and found that satellite streaks affected about 20–25% of twilight images.

But other observatories face larger challenges — particularly the Vera C. Rubin Observatory, an 8.4-metre-wide telescope funded by the United States and under construction in Chile. Because it will photograph the entire visible sky every three days, it will be particularly vulnerable to satellite streaks trailing through its images.

Rawls and other astronomers are working on ways to mitigate the damage, such as developing algorithms that can identify and erase satellite streaks from the data. But fixing the data still takes a lot of time and energy. "It's certainly eating my career," Rawls says.

Other, broader impacts could affect life worldwide: the presence of satellites contributes to a background glow in the sky that can disorient animals that rely on celestial navigation. Satellite streaks can also interfere with human knowledge systems, such as Indigenous knowledge systems that rely on information from dark skies to mark important events throughout the year.

"In the same way that our lands were colonized, our skies are now being colonized," says Karlie Noon, a PhD candidate in astronomy and an Indigenous research associate at the Australian National University in Canberra. "And this isn't just Indigenous people." She points out that companies have launched satellites without necessarily consulting the scientific community.

Some satellite operators have been working to mitigate the problem. Companies including SpaceX, OneWeb in London and Amazon's Project Kuiper in Seattle, Washington, have met regularly with the IAU and national astronomical societies to discuss ways to reduce the satellites' impact. SpaceX has tested methods of dimming its Starlinks, including installing sunshades. The sunshades do reduce the satellites' brightness[3], but they seem to have been left off the latest generation of Starlinks. Those satellites, launched since last September, use lasers instead of radio to communicate with one another, and the sunshades interfere with those communications.

**"This is an unsustainable trajectory. At what point will we miss a discovery?"**

SpaceX is instead working on other mitigation methods, such as adding stickers or other materials to satellite mirrors to reflect light away from Earth, David Goldstein, an engineer with the company, said during a webinar hosted by the UK-based Federation of Astronomical Societies (FAS) earlier this month.

How well that might work is still being sorted out. An unpublished analysis of 102 observations of the brightness of Starlinks over time suggests that those from the new generation seem brighter than those known to have sunshades. However, they are not as bright as the original Starlinks without sunshades, says Anthony Mallama, a retired astronomer in Bowie, Maryland, who ran the analysis.

Meanwhile, OneWeb has launched 428 of a planned initial set of 648 satellites. They orbit at much higher altitudes than the Starlinks do — 1,200 kilometres compared with 550 kilometres. The satellites are typically fainter than Starlinks simply because they are farther away, but they can vary quite a bit in brightness.

One preliminary study of 50 OneWeb satellites during 2021 found that nearly half of them were a little brighter than the 'safe' limit specified by astronomers, says Jeremy Tregloan-Reed, an astronomer at the University of Atacama in Copiapó, Chile. OneWeb says it is committed to reducing the visibility of its satellites; it uses a telescope in Sicily to measure their brightnesses and is drawing on that information to design future satellites that are fainter, Maurizio Vanotti, OneWeb's vice-president of space infrastructure development and partnerships, said at the FAS webinar.

Amazon's Project Kuiper, which would add more than 3,200 satellites, plans to launch its first 2 prototype satellites by the end of this year. One of them will contain a sunshade so that the company can compare its ability to dim the satellites' brightness.


1. Lawler, S. M., Boley, A. C. & Rein, H. *Astron. J.* **163**, 21 (2022).
2. Mróz, P. *et al. Astrophys. J.* **924**, L30 (2022).
3. Mallama, A. Preprint at https://arxiv.org/abs/2111.09735 (2021).