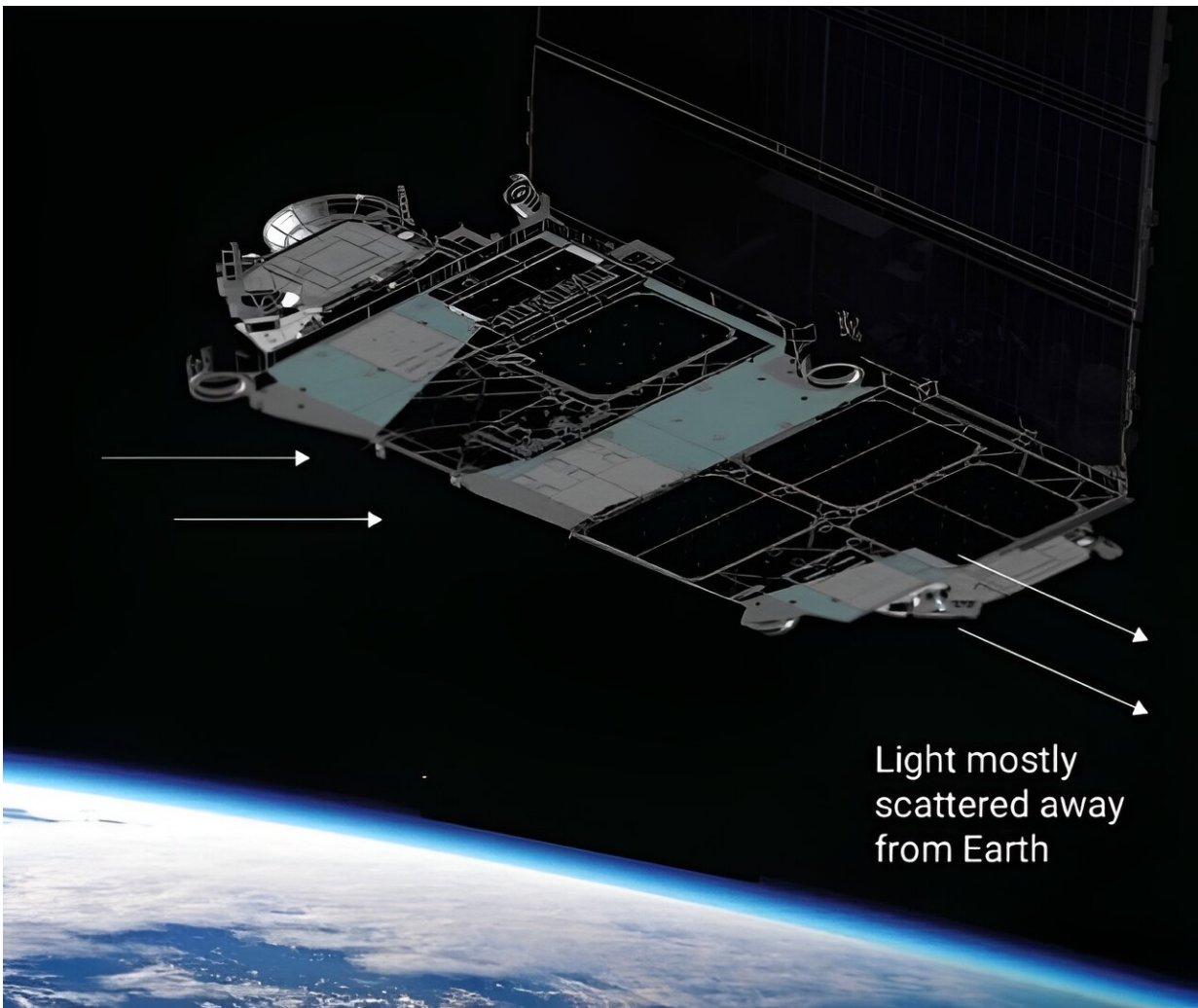


Starlinks can produce surprisingly bright flares for pilots

May 27 2024, by Laurence Tognetti



This diagram and artist illustration demonstrates how sunlight reflects off a Starlink version 1.5 satellite. Credit: SpaceX

How can sunlight reflecting off SpaceX's Starlink satellites interfere with ground-based operations? This is what a [study](#) recently posted to the *arXiv* preprint server hopes to address as a pair of researchers investigate how Starlink satellites appear brighter—which the researchers also refer to as flaring—to observers on Earth when the sun is at certain angles, along with discussing past incidents of how this brightness has influenced aerial operations on Earth.

This study holds the potential to help spacecraft manufacturers design and develop specific methods to prevent increased [brightness](#) levels, which would help alleviate confusion for observers on Earth regarding the source of the brightness and the objects in question.

Here, Universe Today discusses this research with Anthony Mallama of the IAU—Center for the Protection of Dark and Quiet Skies from Satellite Constellation Interference regarding the motivation behind the study, significant results, potential follow-up studies, importance of studying Starlink satellite brightness, and implications for managing satellite constellations in the future.

So, what was the motivation behind this study?

"I study the brightness of Starlink satellites under all circumstances," Mallama tells Universe Today. "That includes their operational phase at 550 km [342 mi] altitude, when they are rising from the initial orbit around 300 km [186 mi] to operation height, ordinary flares which occur frequently but have small amplitudes and these extreme flares."

For the study, the researchers conducted a geometrical analysis of the brightness of Starlink satellites based on the sun's location and angle in the sky. This comes despite SpaceX taking steps to mitigate reflectivity off Starlink satellites, which only decreases reflectivity when the satellites are directly overhead. The study also discussed how reflectivity

from Starlink satellites has affected aerial operations, specifically with commercial airline pilots.

What were the most significant results from this study?

Mallama tells Universe Today, "This study demonstrated that Starlinks can be exceedingly bright under certain conditions. In one instance they were reported as Unidentified Aerial Phenomenon (UAP) by pilots on two commercial aircraft."

Regarding potential follow-up studies, Mallama tells Universe Today, "I am characterizing the brightness of other satellite constellations including Amazon's Kuiper, AST SpaceMobile's BlueWalker/BlueBirds and Planet's Pelicans."

The study mentions how the UAP incidents occurred in 2022 and was recently discussed in Buettner et al (2024) with the pilots' reporting brightness magnitudes (also called stellar magnitude or apparent magnitude) of -4 to -5. For context, a stellar magnitude of -5 is equivalent to the planet Venus at its brightest, which is known for being observed before sunrise or after sunset periodically throughout the year. The apparent magnitude scale ranges from -30 to 30 with higher numbers corresponding to decreasing brightness.

Buettner et al (2024) was recently presented at the 4th IAA Conference on Space Situational Awareness ([ICSSA](#)). That paper discussed how the incident occurred on August 10, 2022, and was observed by five pilots aboard two separate commercial airline flights over the Pacific Ocean, which resulted in two photographs obtained by the pilot's cell phones.

After analyzing a series of simulations and additional data, the researchers determined these UAPs were Starlink satellites launched earlier that day, which were designated as Starlink Group 4-26. Given

this incident, what is the importance of studying Starlink brightness/flaring?

Mallama tells Universe Today, "The importance of studying Starlink brightness is that the satellites interfere with [astronomical research](#) if they are brighter than magnitude 7. Furthermore, casual sky watchers, such as amateur astronomers and naturalists, are distracted by those brighter than magnitude 6 because they are visible to the unaided eye."

This study comes as SpaceX's Starlink constellation continues to grow on a regular basis, with the number of current Starlink satellites in orbit having reached more than 5,600 with almost 6,000 having been launched by SpaceX as of this writing.

As noted by both the study and Mallama, sunlight reflectivity off Starlink satellites causes issues with both aerial operations on Earth and astronomical observing, with Mallama also conducting research on satellite constellation brightness for Amazon, AST SpaceMobile, and Planet Labs. Therefore, with the number of satellites in orbit rapidly increasing due to constellations, what implications could this study have on managing satellite constellations in the future?

Mallama tells Universe Today, "One approach to reducing satellite brightness is to reflect sunlight into space rather than allowing it to scatter diffusively toward observers on the ground. That works very well most of the time. However, there are certain sun-satellite-observer geometries where it fails and observers see a mirror-like reflection of the sun."

Mallam published a [2023 article](#) with Sky & Telescope discussing how SpaceX's second-generation of Starlink satellites are fainter than their predecessors.

Mallama credits his co-author, Richard Cole, as playing a "crucial role" in this study, noting how Cole "predicted the extreme flares based on his numerical model of Starlink satellite brightness."

How will sunlight reflectivity off Starlink satellites influence ground operations in the coming years and decades, and what steps can be taken to mitigate this activity? Only time will tell.

More information: Anthony Mallama et al, Extreme Flaring of Starlink Satellites, *arXiv* (2024). [DOI: 10.48550/arxiv.2405.13091](https://doi.org/10.48550/arxiv.2405.13091)

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