Column

Explained in 60 Seconds: Impact of Satellite Constellations in Astronomy

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Astronomers are living in a conundrum. The development of space and technology has now allowed for private and public organisations to create large satellite constellations. These 'constellations' of similar type and function operate in unison and are deployed for a variety of purposes, including geodesy, satellite telephony, Earth observation, and most recently global satellite internet[1]. While astronomers, in general, acknowledge the merits of worldwide internet services that satellite constellations can supply, especially to previously hard-to-reach areas, there are repercussions for anyone who looks at the night sky. The good news is that these repercussions can be partially mitigated and many organisations are working on it.

Within the field of astronomy, there are new observatories and instruments coming online in the next decade that will substantially increase humanities' understanding of the universe. However, these new capabilities require a dark night sky to uncover the secrets of the most fundamental questions about the nature of our universe as this next decade will also see the launch of over 100,000 satellites into low-Earth orbit.

In order to investigate the impact from these satellite constellations to the field of astronomy, as well as possible mitigation strategies, two workshops were conducted in 2020, SATCON1 (June) and Dark and Quiet Skies (October). Astronomers and individuals from the satellite and illumination engineering industries, among other stakeholders, conducted research and held discussions in the areas of observation, simulation, mitigation testing, and metrics to produce recommendations for stakeholders. The results were presented at the workshops and published in reports online[2].

The reports suggest several strategies for observatories and satellite companies to mitigate the impacts associated with satellite constellations. These strategies include lowering satellite orbits so that they are in the Earth's shadow much of the time, using materials on the satellites that are less reflective (e.g., darkening them with paint or sun shields, as SpaceX has done), adjusting attitudes so that most of the surfaces of the satellites are not facing the Earth, having fewer satellites launch (and only the number needed), orbit-raising or deorbiting satellites as soon as possible, supplying astronomers with the location and timing of these satellites over the observatories, and helping astronomers create avoidance and streak removal software.

At this point in time, no combination of mitigation strategies will completely remove the impacts of low-Earth orbit satellite trails on the science programmes for the upcoming generation of optical astronomy facilities. If the companies cannot meet astronomers even part way, then satellite constellations will endanger these new technology telescopes coming online in the next decade, just as existing telescopes have been affected. Additionally, this issue of dark skies affects more than just professional astronomers; satellite constellations are even impacting amateur astronomy and cultural traditions like wayfinding now.

The next workshops on the effects of satellite constellations on astronomy will be held in May and October 2021. Both meetings will use the reports from the first workshops to explore ways astronomers, satellite operators, and other stakeholders can collaborate on implementing the highest-priorities or most achievable recommendations and consider the resources required to do so. The Dark and Quiet Skies executive summary will be presented at the UN COPUOS[3] Science and Technical Subcommittee meeting in April 2021 to increase global awareness of this issue.

Notes

[1] International Astronomical Union theme "Satellite Constellations": https://iau.org/public/themes/satellite-constellations/

[2] Reports from the 2020 satellite constellation workshops on the NOIRLab website: https://noirlab.edu/public/products/techdocs/

[3] UN Committee on the Peaceful Uses of Outer Space (COPUOS) website: https://www.unoosa.org/oosa/en/ourwork/copuos/index.html

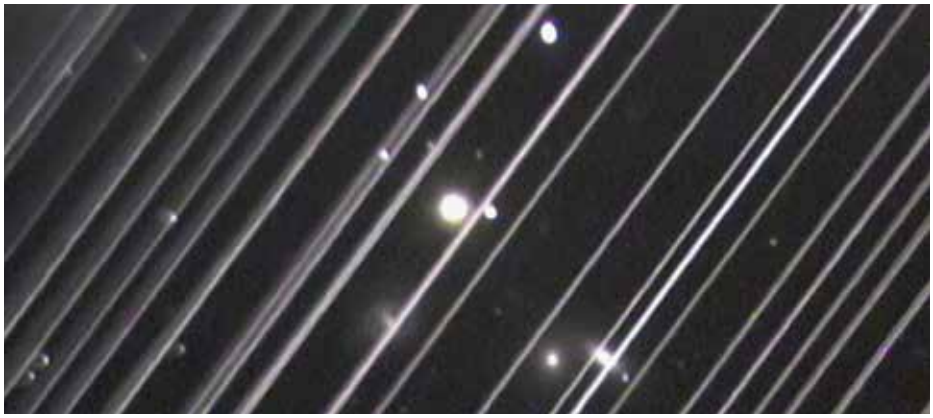

Figure 1. *This image, taken on 25 May 2019 with a telescope at Lowell Observatory in Arizona, US, illustrates the impact of satellite constellations on research programmes in astronomy. The diagonal lines running across the image are trails of reflected light left by more than 25 Starlink satellites as they passed through the telescope's field of view. Credit: Victoria Girgis/Lowell Observatory*