The Future of Observing Artificial Satellites

Brad Young, Astronomy Club of Tulsa

Observing artificial satellites has been a hobby among amateur astronomers since the very beginning, with the launch of Sputnik in 1957. At first, the hobby was a well-organized citizen science effort focused on determining the orbits of what at first were seen as elements of terror and supremacy of the Soviets. Later, observations for scientific and tracking purposes were gradually taken over by Baker-Nunn cameras and radar, but the hobby aspect remained. As the 1970s ended, a small group of hardcore observers remained, and the formative years of satellite observing passed with elements and predictions sent through surface mail and later via the early Internet.

Along the way, different categories evolved. As the number of objects grew, people specialized in objects that flashed or periodically flared up to brighter than Venus's magnitude. Or an observer might specialize in tracking and reporting only those payloads that were classified and lacked any published orbital elements or predictions. Instead, predictions were made by amateur orbital analysts, based on the observations sent in by other hobbyists. This symbiotic cooperation kept things going through the 00s. Ultimately, the decision to declassify a large amount of these payloads in the 2010s made this less important to observe.

Satellites were getting smaller too, as along the way improvements were made in technology to serve the ever-present quest to reduce weight. Coupled with this, as space became privatized, the fees for launching were reduced and opened space to a wider group of consumers. Those consumers included NGOs that wanted as much space science as they could do for minimal cost, using CubeSats and Nanosats. More and more, the satellites that were launched became nearly impossible to see without optical aid, and even binoculars were not able to resolve the smaller and dimmer objects. Stricter agreements about LEO debris led to the deorbiting of rockets after the mission was complete. Although some rocket bodies remained in orbit, in general artificial satellites were becoming much more numerous but much less observable.

And then came Starlinks, OneWeb and other communication satellite megaconstellations in prototype and production missions, increasing the number of objects at a startling rate. Starlinks and others (e.g., Blue Walker 3) are, at first, quite observable right after launch. Relatively bright, they could often be seen naked eye or spotted in handheld binoculars.

Therein lay a growing problem; the new objects were so numerous and bright that it became clear that they were interfering with observations by ground-based telescopes. Although the exact effect on the science of astronomy is not yet understood, it was easy to see that with this large increase in objects the situation would become critically damaging in only a few years. The astronomy community, both professional and amateur, voiced their concerns in the media and in space situational awareness forums all over the world.

Luckily, SpaceX has made significant strides in reducing the optical brightness of their newest satellites. Although there is more research to be done, it appears that the Starlink Generation 2 satellites meet the specifications set by the IAU of a standard magnitude of 7.0 or dimmer. There are still some questions as to how well current control can be maintained over time and whether radio frequencies are still in peril, but at least the work is being done to reduce the effect of this new source of interference.

As crucial as that development is, now even Starlinks are barely observable by amateurs. Eventually, the original Starlinks will be deorbited and only the faint ones will remain in orbit. The trend towards smaller, lighter, and less conspicuous payloads will continue, as the goal of weight minimization is still attractive economically and will remain so.

On occasional launches, especially by American and foreign governments for intelligence and security purposes, the payloads maybe similar in size and brightness to the old school launches that were seen when the hobby began. There is also an increased number of manned missions and with both the Chinese and International Space Station in operation, flights of payloads of reasonable size will continue to service and maintain those facilities. But the days of all launches being carried aloft by a large rocket that remains in orbit for years, and a single large payload that is low enough and large enough to be seen easily appear to be ending.

So, what is the amateur satellite observer to do? There are several options if one is willing to think outside the box.

- Geosynchronous satellites will at least for the time being remain large and conspicuously bright during the equinoctial seasons with their solar panels face on to the viewer.
- Listening to satellites has not changed, in fact things have gotten better on this front due to the increased number of sources that have been launched.
- There will still be the occasional large rocket body used to lift the large number of simultaneous payloads that have become commonplace today.
- If you reach beyond modest equipment into widefield photography, the prospects broaden also. Now you can integrate the dim light of smaller satellites, and capture fields full of them instead of concentrating on only one target.
- Remote imaging allows for geosynchronous satellites in longitudes that you can't see at home and will reach much dimmer objects easily. An issue there is that the commercial services available are not set up to accept satellite predictions.

All in all, satellite observing is changing again with the times. In the very beginning there were only a few objects and although they might be bright, it was very difficult to know where and when they would appear, and the equipment available amateurs was very limited usually only their eyes binoculars and perhaps a small telescope. Now, we have much more sophisticated technology to use, and it will probably be needed. The age of large satellites and rockets is over, at least in LEO. Some targets may be easy to see for just a few days after launch, but many will be invisible to anything, but sophisticated imaging equipment used by amateurs who are well-versed in how to develop spot on predictions and make it happen.