Canada

Agenda Item 15 – Dark and quiet skies, astronomy and large constellations: addressing emerging issues and challenges
Delivered by: Laura-Alexe Marcoux, Canadian Space Agency

Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
Sixty-second session, Vienna, February 3rd-14th, 2025

Chair, Distinguished Delegates,

Increasing optical interferences from growing satellite constellations could have a significant impact on the sensitive astronomical observatories that are operated by international partnerships across the globe. These observatories require dark skies to achieve their fundamental purpose – to probe fundamental physics, to learn the life-cycle of planets, stars and galaxies, and to understand the context and development of life in the Universe. Historically, astronomical needs for dark skies have been met through the use of remote, secluded sites, despite their considerable inconvenience and corresponding expense. However, even these select areas will see an impact from satellite constellations, and international efforts will therefore be required to develop and implement effective mitigation strategies and thus realize the benefits of these constellations without significantly impairing humanity's view of the Universe.

Over the past 50 years, Canada and its international partners have established a number of ground-based optical-infrared observatories such as the Canada-France-Hawaii Telescope (CFHT) and the International Gemini Observatory (IGO). These observatories enable access for the Canadian and international astronomical communities to powerful, world-class observing capabilities including wide-field cameras capable of imaging large areas of the sky in exquisite details. Canadian astronomers and their collaborators have leveraged such imaging capabilities to establish a worldwide reputation in conducting large surveys that have consistently delivered ground-breaking discoveries and higher bibliometric impacts than more focussed observing programs. They can probe different timescales corresponding to different astrophysical transient phenomena by repeatedly imaging the same sky locations through multiple visits at different cadences. Surveys represent large investment of observing time (100s of nights over many years) and a proportionally higher risk of exposure to optical interferences.

Deep images of the sky are produced by collecting and stacking large numbers of images. The algorithms used in the stacking can be configured to remove optical interferences as long as they do not appear at the same locations over a significant fraction of the images in a stack. The relatively short duration of individual satellite events is helpful in this case, but higher numbers of satellites might ultimately produce a cumulative impact that cannot be mitigated without significant improvements to existing algorithms. Deep image stacking typically involves large amount of data that must be processed at once, and as satellite interference grows, more computationally intensive data reduction strategies will be required for standard astronomical data processing. We therefore continue to invest in astronomical data processing initiatives such as the Canadian Astronomy Data Centre (CADC) at the National Research Council Canada that are used not only by Canadians but also the broader international astronomy community.

The pursuit of time-domain astronomy, which requires observations on timescales as short as a few tens of seconds, has emerged as a top-priority to probe powerful phenomena, e.g., supernovae, bursts, and the distribution and size of objects in the outer Solar System through direct observations or stellar occultations. Countries have invested heavily to develop observing capabilities in this area including the Vera C. Rubin Observatory which will begin science operations this year with contributions from various countries including Canada. The shorter observing timescales are closer to the timescale of passing satellite events, and this may make this type of observations more susceptible to optical interferences. Fully removing the effects of satellite trails has proven extremely difficult, and remains a significant source of false positive identification of moving objects. Quantitatively, a survey of Solar System objects like CLASSY at CFHT sees approximately 2-6 streaks per hour, with the streaks spanning the entire length of the camera field of view, and are bright enough to consider all intersected pixels as lost data. These rates tend to increase closer to twilight where satellites appear brighter. As well those streaks interfere with source detection causing a ~5% loss (or an effective 5% increase in program cost) at current satellite densities. Mitigation strategies are limited and range from rejecting affected observations to better statistical identifications of optical interferences.

The interest in optical interferences in our community is very high, and community members have been very active with strong participation in workshops, townhalls and committee reports. These efforts have produced a number of helpful recommendations aligned with other similar efforts in other countries that are being taken into consideration by relevant government agencies. This alignment again reinforces the need for coordinated efforts at the international level.

Although astronomers have been so far able to partially mitigate optical interferences through a combination of careful observation planning, innovative instrumentation choices and better data processing algorithms, there remains substantial uncertainty about long-term impacts as the number of satellites continues to grow. Sophisticated modelling based on ongoing surveys, some led by Canadians, will be key to producing higher fidelity forecasts, and we will continue to actively participate in these modelling efforts.

As even more powerful facilities such as Rubin/LSST and Extremely Large Telescopes become operational, the need for dark skies for astronomical research will remain of prime scientific importance, and we believe that international cooperation and collaboration is essential to understanding and mitigating the impact of satellite constellations on astronomical observations.

Thank you for your kind attention.