IARCO Research proposal Final - Nour Hicham.pdf

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IARCO Research proposal

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Research Topic: How do satellite constellations affect ground-based astronomy, and what solutions are possible?

1. Research Question → *One clear question*

"How do large satellite constellations, such as Starlink, affect the quality of ground-based astronomical observations in the visible and infrared spectrum?"

2. Research Problem → *What is happening, why is it a problem?*

In recent years, observing the night sky has been difficult not only for the naked eye, but also for many scientists and observers. Because of the rise of constellation satellites, instead of finding stars, thousands of bright artificial trails silently cross the sky [1]. Yet, it is a reality for observers around the world. Over the past few years, multiple space companies have launched vast constellations of satellites, like SpaceX, into low Earth orbit to provide global internet access [1]. While this technology is crucial, it comes with consequences: the gradual loss of visibility of the natural night sky [1]. The increasing number of reflective satellites is now interfering and now poses challenges to scientific observation, and even with the simple human experience of looking up at the stars [3]. In response to these challenges, many observatories, including the American Astronomical Society (AAS), the International Astronomical Union (IAU), and the Royal Astronomical Society (RAS) collaborating with ESO, are already taking action to raise awareness of this issue globally in the UNPUOS to discuss solutions [4], [5]. In fact, these observatories are concerned about the effects that these satellites will have on ground-based optical and infrared astronomical observations [4].

3. Existing Literature → *What have others said about this before?*

Many previous studies had already reported that constellation of satellites was impacting our night sky view in various ways. In 2020, Hainaut & Williams estimated that more than 26,000 fixed satellites would pollute the data from visible and infrared telescopes of the European Southern Observatory [3]. According to a 2022 NOIRLab report, even short satellite trails can slice through long-exposure images, making entire observations unusable and, in some cases, eliminating the possibility of capturing certain types of observations [4]. Moreover, Kyba et al. proved that citizens were impacted too. In fact, the artificial lighting from satellites is increasing, causing the number of visible stars to decrease drastically to the naked eye [5]. In addition, McDowell alerted us to the fact that Starlink satellites are radiating spurious radio signals that are drowning out the weak signals from space that radio astronomers are trying to detect [2]. The problem is not limited to optical astronomy — large installations such as the Atacama Large Millimeter/submillimeter Array (ALMA) and the Atacama Pathfinder Experiment (APEX) have also expressed concerns of potential disruptions due to satellite transmissions [5]. In this context, the European Southern Observatory (ESO), with observer status in the Committee of Radio Astronomy Frequencies (CRAF), is working closely with North American and East Asian ALMA partners to safeguard the radio spectrum for scientific use [1].

While these studies clearly address the problem, there is still limited research showing how we could effectively balance technological evolution and preserve the natural night sky. Which is the purpose of my research.

4. Methodology → *How will I conduct this research?*

- **Type of research:** This research is going to be using a qualitative approach based mainly on literature review. Instead of conducting quantitative experimental or observational work, this research will focus on collecting, comparing, analysing and interpreting from existent institutional reports and scientific publications [3], [4], [5].
- **Sources of data:** All information for this research will be collected from a variety of sources to ensure a comprehensive and multidisciplinary approach. Firstly, peer-reviewed scientific articles, including Hainaut & Williams, McDowell, Kyba, and more [2], [3], [5]. Secondly, institutional reports from organizations such as ESO, NOIRLab, the IAU, and the AAS will play a key role in informing this research [1], [4]. Moreover, official statements and documentation from satellite operators such as SpaceX, OneWeb, and Amazon Kuiper will be analyzed to explore potential mitigation strategies [2]. This data will also include all tracking data obtained from public satellite databases, such as CelesTrak and Space-Track.org, to monitor current satellite deployments [5]. Finally, in addition to academic and institutional sources, it will also conduct a short online survey to collect public opinions (n=100) on how people perceive the visibility of the night sky today compared to previous years. This will provide a human perspective to complement the scientific data.
- **Criteria for analysis:** This research will analyze the effects of satellite constellations from professional and radio astronomy to public perception, focusing on three main areas: visual, scientific, and cultural consequences: visual impact (loss of star visibility in the night sky), scientific impact (disruption of optical, infrared, and radio astronomy), and cultural impact (effects on public stargazing and the symbolic value of the night sky) [1], [2], [12].
- **Case study approach:** In this research, a comparative analysis will be conducted between: conditions before and after the deployment of major satellite constellations such as Starlink, but also the impact on optical astronomy versus radio astronomy, to determine which branch is most affected [3], [5].
- **Limitations:** This research will be limited to ground-based astronomy and will not cover space-based telescopes such as Hubble or the James Webb Space Telescope. Additionally, since the study relies on secondary data, it will be constrained by the availability and transparency of existing research and corporate documentation [11].

5. Research Topic Justification → *Why is this important and innovative?*

This research is both important and innovative because it addresses an issue that is affecting key aspects of astronomy, including astrophotography and observational studies. These areas are particularly very important, as they provide some of the few experimental "proofs" we have about the universe, and disruptions caused by satellite constellations could ruin the accuracy of observations and affect future discoveries [1], [2], [3]. Despite the growing presence of large satellite constellations, this problem has received attention from

major astronomical organizations, but still many people are unaware of this issue [4], [5]. By demonstrating these impacts comprehensively, this research could raise awareness, inform about mitigation strategies, and accelerate the development of practical solutions to preserve both scientific research and the public's experience of the natural night sky.

6. Quality of Writing → *Short confirmation*

The disruption caused by satellite constellations not only affects scientists but also the general public. This research will be presented in a clear, accessible, and fluent manner, ensuring that all participants and readers can understand each point and aspect of the study. By communicating the issue effectively, the study aims to raise awareness and encourage continued discussion about the impact of satellite constellations on both professional astronomy and the public's experience of the night sky. It will also discuss potential solutions to prevent further loss of the natural night sky.

7. Conclusion → *To summarise everything up*

To summarise everything that has been stated so far, this proposal addresses an urgent and neglected problem: the effect of satellite constellations on professional astronomy and the public's night sky experience. Through a meta-analysis of literature, institutional reports, satellite tracking data, and public survey results, the research examines potential visual, scientific, and cultural effects from varying angles. The results will not only enhance our knowledge of the issue caused by satellite constellations with optical and radio astronomy, but will also inform about possible mitigation measures. In the end this research is designed to contribute to awareness, decision- and policy-making, and action toward preserving the quality of astronomical observations and the natural beauty of the night sky for generations to come.

8. Références (IEE) :

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