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FIRST OBSERVATIONS OF DTC STARLINK SATELLITES AND MAGNITUDE EVALUATION

Abstract

SpaceX's Starlink satellites have revolutionized the field of satellite constellations, introducing the so-called large constellations: arrays of thousands of satellites aimed at delivering services to people on the ground. Currently, the Low Earth Orbit (LEO) region of space surrounding Earth accounts for nearly 20,000 space objects, including satellites and space debris, of which 5,400 represent Starlink satellites. According to the authorizations received by SpaceX, the number is expected to reach the 12,000 units in the next years. Moreover, other companies are following the path mapped by SpaceX, like OneWeb, accounting for 630 LEO satellites. The large number of deployed satellites threatens the missions in LEO orbit and causes continous interference with ground-based astronomy. For this reason, Space Traffic Management (STM) arose as a fast-evolving field of research, aimed at ensuring the safety of space operations. In this framework, Starlink clearly represents the perfect case study. Several configurations of Starlink satellites have been deployed since the beginning of the project, all resulting in significant light pollution. SpaceX has expended a lot of effort to mitigate the sunlight reflected by Starlink satellites, therefore reducing interference with astronomical imaging. The most recent configuration is the Direct-to-Cell Starlink, with six prototypes launched at the beginning of 2024. These spacecrafts deserve special attention since they are placed in a circular orbit at around 360 km, compared to the nominal Starlink height of 550 km. Additionally, they feature larger antennas compared to the previous Starlink V2.0 Mini. This study intends to investigate the impact of Direct-to-Cell Starlinks on the night sky by tracking their passes with optical telescopes and assessing their brightness. Observations are performed with SCUDO, an observatory located in Collepardo, Italy, part of the Sapienza University of Rome observatory network. Measurements of brightness variation, i.e., light curves, are acquired using a Johnson V photometric

filter and correlated with range, elevation, altitude, solar phase angle, and time of observation. The acquired measurements can be compared with previous observations regarding Starlink V1.0, V1.5 and DarkSat, characterizing the brightness of the different configurations and evaluating the measures adopted by SpaceX to mitigate reflected sunlight. Results can be useful both for other observers as a comparative mean and for satellite manufacturers, especially when considering the design of future satellites with an approach aimed at minimizing reflected sunlight.