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THERMAL INFRARED MAGNITUDES OF LOW EARTH ORBIT SATELLITES

Abstract

Observations in the thermal infrared (IR) offer the potential of detecting satellites not visible in the optical, or detectable with great difficulty. An example would be small satellites in sun-sync orbits, which may be too faint for detection in daylight observations and at night will be in Earth shadow. In addition, the effect that large constellations of satellites in Low Earth Orbit (LEO) will have on observational astronomy is a matter of urgent concern today. In the optical and near-IR satellites in sunlight will leave streaks in imaging detectors. Thus when the satellites are in Earth shadow, they should not be detected. But in the thermal IR (example at 10 microns wavelength) the satellites can be detected by their thermal emission even when they are in Earth shadow. We estimate the thermal brightness of LEO satellites in standard astronomical systems and compare with the brightness of stars. As the satellite enters Earth shadow, it will no longer be heated by the Sun and thus will cool down, becoming fainter in the thermal IR until it reenters sunlight. Thermal data from two Sapienza University of Rome CubeSats, WildTrackCube-SIMBA and LEDSAT, will be used to estimate this effect. In addition, measurements at 12 microns by the WISE spacecraft of GEO objects will be scaled to LEO altitudes and ranges and used to estimate brightness of satellites just prior to shadow entry, although the thermal environment at LEO is different than at GEO. Observational techniques in the thermal IR are very different than in the optical. Thermal IR detectors are much smaller and have a much faster readout time than optical detectors. We comment on this and the effect large constellations of LEO satellites will have on astronomical observations in the thermal IR.