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LIGHT CURVES SEQUENTIAL COMPARISON STRATEGY FOR IMPROVED UNDERSTANDING OF LEO UNCONTROLLED OBJECTS

Abstract

In the framework of Space Situational Awareness (SSA) activities, space debris light curve analyses have been used as a tool to study the tumbling motion of uncontrolled orbiting objects, by means of just optical data and often with no assumed data on their geometry. Through this strategy, it is possible to perform frequency analysis to extract the objects' rotation period, necessary to predict variations in attitude for both monitoring and management purposes. In the context of International tasks and activities, such as the ones foreseen for the Inter-Agency Space Debris Coordination Committee (IADC), the Sapienza Space System and Space Surveillance Laboratory (S5Lab) research group at Sapienza University of Rome, on behalf of the Italian Space Agency (ASI) delegation to IADC, has created a historical record

of light curve data, carried out by observing of seven LEO rocket body objects (R/B), including the Russian SL-8, SL-14 and SL-16 R/B, the Chinese CZ-4C and CZ-11 R/B and the American Pegasus R/B. Such data, supplemented with further investigation during the following years, have exposed a long-term evolution of the motion states, with particular attention to the recorded tumbling rates, which would be unobservable with short-term campaigns. As an example, the SL-14 R/B (NORAD ID 18340) rotation period increase over the years has been discovered through these activities. The aforementioned data allow for long-term evolution light curve inversion and historical analyses over the rotational frequency and photometric response to optical observations, which are in the interest of Space Surveillance and Tracking (SST) and SSA services for database updates, uncontrolled objects monitoring, and in the perspective of future re-entry observations. This article will illustrate the results of the observation campaign and present a sequential comparison methodology to investigate the long term evolution of the rotation rate of space debris. The results of this analysis will offer an improved understating of non-cooperative space objects' behavior. The applicability of the results for future studies and the development of a wider database with historical data over light curve inversion and attitude observations will be assessed and presented in the paper.