An Optical Survey for Space Debris on Highly Eccentric MEO Orbits

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Optical surveys for space debris in high-altitude orbits have been conducted since more than ten years. Originally these efforts concentrated mainly on the geostationary ring (GEO). Corresponding observation strategies, processing techniques and cataloguing approaches have been developed and successfully applied. The ESA GEO surveys, e.g., resulted in the detection of a significant population of small-size debris and later in the discovery of high area-to-mass ratio objects in GEO-like orbits. The observation scenarios were successively adapted to survey the geostationary transfer orbit (GTO) region; and recently surveys to search for debris in the medium Earth orbit (MEO) region of the global navigation satellite constellations were successfully conducted.

Comparably less experience (both, in terms of practical observation and strategy definition) is available for eccentric orbits that (at least partly) are in the MEO region, in particular for the Molniya-type orbits. Several breakup events and deliberate fragmentations are known to have taken place in such orbits.

Different survey and follow-up strategies for searching space debris objects in highly-eccentric MEO orbits, and to acquire orbits which are sufficiently accurate to catalogue such objects and to maintain their orbits over longer time spans were developed. Simulations were performed to compare the performance of different survey and cataloguing strategies. Eventually, optical observations were conducted in the framework of an ESA study using ESA's Space Debris Telescope (ESASDT) the 1-m Zeiss telescope located at the Optical Ground Station (OGS) at the Teide Observatory at Tenerife, Spain.

A first series of surveys of Molnjya-type orbits was performed between January and April 2013. During these four months survey observations were performed during nine nights. A basic survey consisted of observing a single geocentric field for 10 minutes. If a faint object was found, follow-up observations were performed during the same night to ensure a save rediscovery of the object during the next nights. Additional follow-up observations to maintain the orbits of these newly discovered faint objects were also acquired with AIUB´s 1m ZIMLAT telescope in Zimmerwald, Switzerland.

Eventually 195 basic surveys were performed during these nine nights corresponding to about 32.5 hours of observations. In total 24 uncorrelated faint objects were discovered and all known catalogue objects in the survey fields were detected. On average one uncorrelated object was found every 80 minutes. Some of these objects show a considerable brightness variation and have a high area-to-mass ratio as determined in the orbit estimation process.