Properties of the high area-to-mass ratio space debris population at high altitudes

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In the framework of its space debris research activities ESA established an optical survey program to study the space debris environment at high altitudes, in particular in the geostationary ring and in the geostationary transfer orbit region. The Astronomical Institute of the University of Bern (AIUB) performs these surveys on behalf of ESA using ESA's 1-meter Telescope in Tenerife. Regular observations were started in 1999 and are continued during about 100 nights per year. Results from these surveys revealed a substantial amount of space debris at high altitudes in the size range from 0.1 to 1 meter. Several space debris populations with different dynamical properties were identified in the geostationary ring. During the searches for debris in the geostationary transfer orbit region a new population of objects in unexpected orbits, where no potential progenitors exist, was found. The orbital periods of these objects are clustered around one revolution per day, the eccentricities, however, are scattered between 0 and 0.6. By following-up some of these objects using the ESA telescope and AIUB's 1-meter telescope in Zimmerwald, Switzerland, it was possible to study the properties of this new population. One spectacular finding from monitoring the orbits over time spans of days to months is the fact that these objects must have extreme area-to-mass ratios, which are by several orders of magnitudes higher than for 'normal-type' debris. This in turn supports the hypothesis that the new population actually is debris generated in, or near the geostationary ring, which is in orbits with periodically varying eccentricity and inclination due to perturbations by solar radiation pressure. In order to further study the nature of these debris multi-colour and temporal photometry (light curves) were acquired with the Zimmerwald telescope. The light curves show strong variations over short time intervals including signals typical for specular reflections. Some objects exhibit distinct periodic variations with periods ranging from 10 to several 100 seconds. All this is indicative for objects with complicated shapes and some highly reflective surfaces.