APPLICATIONS OF SLR DATA TO THE ATTITUDE DETERMINATION OF DEFUNCT SATELLITES

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The Satellite Laser Ranging (SLR) technology is used to determine the dynamics of objects equipped with so-called retro-reflectors or retro-reflector arrays (RRA). Recent studies showed that these measurements can be used also for the attitude determination purposes. Non-active spacecraft, which are not any more attitude controlled, tend to start to spin or tumble under in influence of the external and internal torques. Such a spinning can be around one constant axis of rotation or it can be more complex, when also precession and nutation motions are present. The rotation of the RRA around the spacecraft's centre of mass can create both a oscillation pattern of laser range signal and a periodic signal interruption when the RRA is hidden behind the satellite.

AIUB is currently performing regular SLR tracking to ENVISAT by using its Zimmerwald Laser and Astrometry Telescope (ZIMLAT). This data is currently internally pre-processed and processed by using AIUB's method of parameter estimation. This method allows monitor the spin axis direction, as well inertial period, and their change over time. In addition to ENVISAT, successful SLR measurements have been conducted for TOPEX/Poseidon satellite and less successful attempts have been performed for OICETS, ADEOS-2, ERS-1, ERS-2 and few GLONASS satellites. The simultaneous observations with SLR and CMOS camera (light curve acquisition) to all mentioned targets revealed that even if the telescope pointing is in real time manually adjusted by the observer no returns can be measured. This is the case when RRA is not facing the observer site. Such observation proof that the ephemerids accuracy is not always the cause of no-returns but sometimes the RRA is simply not visible to the observer.

In our work we will demonstrate how the SLR ranging technique to cooperative targets can be used to characterize the attitude state of defunct satellites, namely ENVISAT. The pre-processing of the SLR residuals data acquired for ENVISAT satellite will be discussed, as well as the possibility of accurate attitude determination using a parameter estimation procedure. Continuous SLR measurements to one target allow accurate monitoring of attitude changes over time which can be further used for attitude modelling and prediction.

Information successful/unsuccessful ranging allows defining visibility regions of the RRA. Fusing this information from more than one SLR station helps defining the spin axis direction in the inertial or orbital reference frame. The information about returns/no-returns cases also allows predicting these windows for a specific SLR station.