Satellites' spin parameters determination from kHz SLR data

Kirchner G., Kucharski D., Cristea E., Hausleitner W., Schillak S.

Ranging to the satellites with kHz laser pulses, effectively scans the surface of each satellite, allowing to identify the echoes of individual retro reflectors or arrays; using this kHz SLR data, it is possible to determine satellite spin parameters, like spin rate, spin direction, and spin axis orientation.

Up to now, by using kHz SLR data only, spin parameters of five targets have been investigated: AJISAI, GP-B, LAGEOS-1, ETALON-1 and ETALON-2.

For AJISAI, we were able to determine spin rate (about 0.5 Hz), and its slow decrease (-0.0077497 Hz / year, with a standard deviation of0.000403 Hz) during a 1.5-year period between 2003/10 and 2005/06. These results were obtained applying spectral analysis methods for the range residuals.

GP-B spin is much slower, with spin periods of 77.5 seconds. While spectral analysis is still applicable, the resulting accuracy is degraded. By using simulations, and comparing the results with actual measurements, we determined spin period, spin direction and spin axis orientation with high accuracy (standard deviation for spin period < 1 s, and for spin axis orientation < 2�).

LAGEOS-1 has the slowest spin (~6000 s) of all investigated satellites. For this object we developed a method to calculate spin axis orientation and spin period from Graz kHz SLR data, which is based on simulation of returns from each retro reflector, with spin period and spin axis orientation as input parameters. Varying these parameters, the simulation generates retro tracks similar to those seen in the kHz SLR data; comparing simulated and measured tracks, allows determination of spin period, and spin axis orientation.

Applying this method to a set of LAGEOS-1 passes - covering a period of more than 200 days - shows also the slow change of the LAGEOS-1 spin axis direction with time.

Using kHz SLR data we determined the spin periods of ETALON-1 and ETALON-2 satellites and their spin period increase during three years. The analysis method is based on comparing spectral analysis results of simulated SLR measurements and real SLR data. The determined spin period values at 2004-01-01 are: TET1 = 63 s/year, and TET2 = 65.5 s. The accuracy of the determined values allows to see the satellites' spin slow down trends: + 0.484 s/year (ET1) and + 0.401 s/year (ET2).