# Spin parameters of LARES spectrally determined from SLR data

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## Abstract

Satellite Laser Ranging is a powerful technique able to measure spin rate and spin axis orientation of the fully passive, geodetic satellites. This work presents results of the spin determination of LARES - a new satellite for testing General Relativity. 1550 SLR passes measured between February 17 and September 15, 2012, were spectrally analyzed. Our results indicate that the initial spin period of LARES is $T_0$=11.64 s (RMS=0.34 s). A new method for the spin axis determination gives orientation of the axis at RA=$12^h22^m48^s$ (RMS=$49^m$), Dec=-70.4° (RMS=5.2°) (J2000.0 celestial reference frame), and the clockwise (CW) spin direction. The half-life period of the satellite's spin is 229.2 days and indicates fast slowing down of the spacecraft.

## LARES

LARES (LAser RElativity Satellite) is designed by Scuola di Ingegneria Aerospaziale at "La Sapienza" University of Rome and manufactured by Carlo Gavazzi Space (CGS) under contract to the Italian Space Agency (ASI). This fully passive, spherical satellite is made of a high density tungsten alloy and equipped with 92 corner cube reflectors (CCRs) for SLR. The CCRs are arranged in the form of 10 rings around the polar axis of the body (Fig. 1).

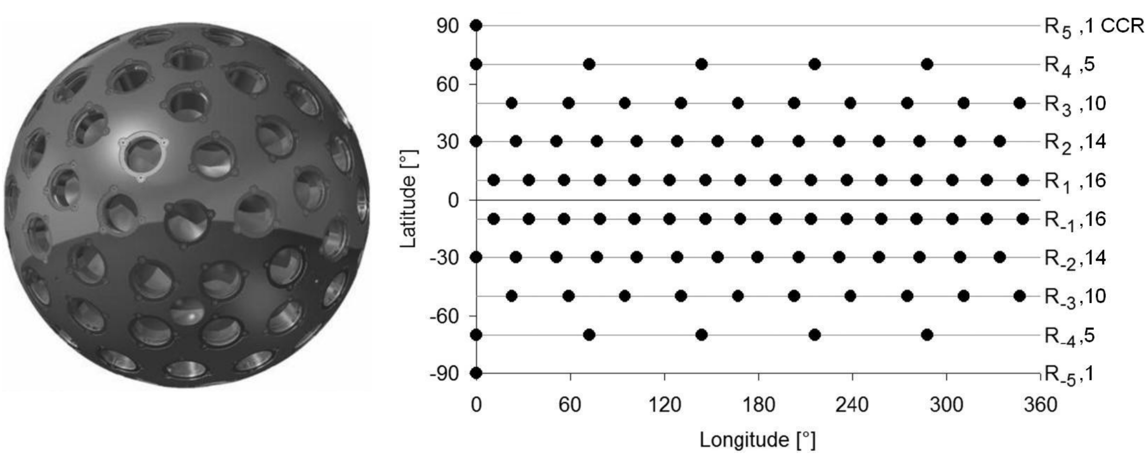


Fig. 1. LARES (courtesy of ASI) and distribution of the CCRs on the satellite. The CCR array consists of 10 rings $R_{-5}$..$R_5$.

The gaps between the prisms on a single ring are constant. The retroreflector array (RRA) holds 2 rings with 16 CCRs at the body's latitude: $R_1$ (10°), $R_{-1}$ (-10°); 2 rings with 14 CCRs: $R_2$ (30°), $R_{-2}$ (-30°); 2 rings with 10 CCRs: $R_3$ (50°), $R_{-3}$ (-50°); 2 rings with 5 CCRs: $R_4$ (70°), $R_{-4}$ (-70°); and

2 single CCRs placed on the poles of the body. All cubes are of the same type - made from Suprasil 311, not coated.

## Spin rate

In order to determine the spin rate of LARES (Kucharski et al., 2012) we used the SLR data produced by the ILRS network stations between February 17 and September 15, 2012. We have selected 1550 passes which give a clear spectral signal with power higher than 10. Every selected pass is processed and the range residuals are calculated (with respect to predicted orbits); as the next step the frequency analysis is performed and the spectral signal is obtained. The resulting spin frequency of the satellite is calculated as a mean value of the harmonics visible in the spectra. The results indicate slowing down (Fig. 2) of the satellite what can be expressed by the exponential trend function of the spin period:

$$T = 11.6447 \cdot \exp(0.00302442 \cdot D), \text{RMS} = 0.34 \text{ [s]},$$

where D is the number of days since launch.

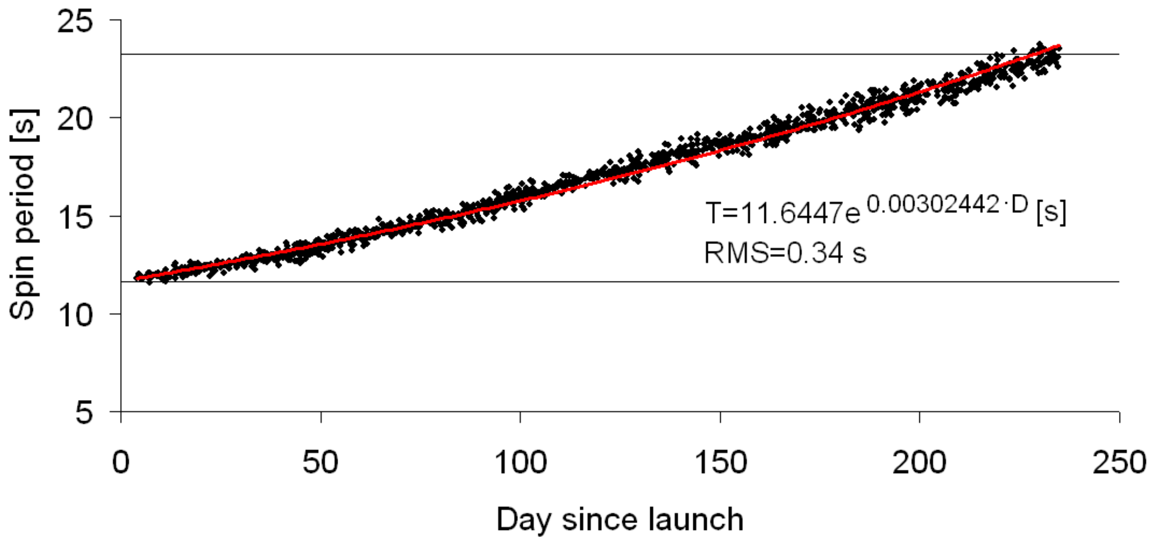


Fig. 2. Spin period of LARES

The initial spin period is $T_0$=11.64 s, RMS=0.34 s. The half-life period of the satellite's spin is 229.2 days - the spin period doubles after this time.

## References

Kucharski, D., Otsubo, T., Kirchner, G., Bianco, G. Spin rate and spin axis orientation of LARES spectrally determined from Satellite Laser Ranging data. Adv. Space Res., doi:10.1016/j.asr.2012.07.018, 2012